

Natural Science

A Monthly Review of Scientific Progress

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NOTES AND COMMENTS.

Moult as a Means of Defence.

IT was Romanes who said, "Wherever we tap organic nature it seems to flow with purpose," and post-Darwinian naturalists have far excelled the authors of the Bridgewater Treatises in the ingenuity of their search for the utilitarian justification of occurrences. It must be admitted, however, that there are some vital processes where the seamy side is conspicuous, and one of these is ecdysis or moult. The expensiveness, the fatigue, the riskfulness of the process cannot be ignored, even if the progress of research should make its physiological inevitableness much more intelligible than it is at present. It is with interest, therefore, that we note a communication by Künckel d'Herculaïs (*Comptes Rendus Acad. Sci.*, Paris, cxxviii. 1899, pp. 620-622) in which it is pointed out that the moult of insects is a means of defence against animal and plant parasites. In seeking to infect young locusts (*Schistocerca peregrina* Olivier) with the spores of the fungus (*Lachnidium acridiorum* Giard) which he discovered on the adults, Künckel d'Herculaïs was struck by the fact that the repeated moult—every eight days—made the fixation of the spores on the integument exceedingly difficult. Even if entrance be found through the stigmata, the casting of the internal lining of the tracheæ is effectively antagonistic to infection. In the same way, the casting of the intestinal lining was shown to free another species of locust (*Schistocerca paranensis* Burmeister) from a burden of Gregarine parasites. Thus there is advantage as well as disadvantage attendant on the physiologically inevitable process of moult, and there is some practical interest also in what the author has observed, since the moult will evidently tend to hinder the elimination of the locusts by inoculation,—a method which has been of late regarded with some hopefulness in various locust-infested countries.

Nitragin and Nodules.

ONE of the last communications on the much-discussed problem of the nodules of leguminous plants is a paper by Miss Maria Dawson

(*Proc. Roy. Soc.* lxiv. 1899, pp. 167, 168). The author has been led to an unhesitating confirmation of the parasitic nature of both the filaments and the bacteroids contained in the nodules. The filaments, it was found, have no constant relation to the nucleus of the cells as was represented by Beyerinck in 1888. The infection-tube which grows into the root-hair consists of strands of straight rodlets, which burst out here and there, and become transformed into X, V, and Y-shaped bacteroids, incapable of further growth. As the rodlets multiply by fission, the author refers them to the Schizomycetes, but leaves it an open question whether they are true bacteria. Commercial nitragin *does* consist of the tubercle organism, as its advocates assert, and as a result of the inoculation of either seeds or soil with it, tubercle formation ensues. In the commercial product the organisms are present as micrococcus-like bodies, all straight and immobile, which become converted into bacteroids and straight rods in pea-extract. The cautious practical conclusion is that the addition of nitragin to soils rich in nitrates appears to be inadvisable, but a supply of it to soil poor in nitrates results in an increased yield, though better results are obtained if, instead of nitragin, nitrates be added to the soil.

Classification of Variations.

ABOUT a year ago, Professor G. Schwalbe delivered before the German Anatomical Society an interesting address on the classification of variations, which seems to have received but little attention in this country. It is to be found in the *Ergänzungsheft* to the fourteenth volume of the *Anatomischer Anzeiger*, and well deserves the consideration of evolutionists. With some of his categories of classification all who have interested themselves in the subject of variation are familiar, the distinctions between continuous and discontinuous, substantive and meristic variations, and between blastogenic or germinal *variations* and somatogenic *modifications*; but there is at the end of the address a contrast which we do not remember to have seen so clearly put before. It is that between those variations which may be described as due to incompleteness in the inheritance, and those which cannot be so described, being distinctly "new departures," possibly due to the influence exerted on the germ-plasm by environmental stimuli, either directly or by changes evoked in the metabolism of the body.

Local Colour in Universities.

WE referred some months ago to Mr. Chamberlain's wise remark at Birmingham that universities should have local colour, that they should

in some feature of their organisation be eminently adapted to their social milieu. A predominantly classical university at Birmingham might commend itself to those who believe in taking a cold to cure a fever, but there is little reason to believe that it would be practically effective. It would be like making a special feature of mining at Aberdeen, or of polar exploration at Khartoum, or of commercial education at St. Andrews, or of marine biology at Moscow. With these sentiments it was with much pleasure that we read the first paragraph of the Rectorial address delivered on the 6th of March by Professor Karl Brandt at Kiel.

That the University of Kiel, he said, is a university by the sea, has had as a natural result that many members of the professoriate have turned their attention to the problems which the sea always presents. Especially has this been the case since 1870, when the Kiel Commission was charged with the scientific investigation of German seas, to the end that their practical exploitation might be more effective. "Not only for zoologists, botanists, and oceanographers, but for chemists, physicists, physiologists, histologists, and hygienists, the sea which lies before us presents valuable material for investigation. And the fact that a number of the University teachers are also connected with the Marine Academy has brought representatives of various disciplines, which might otherwise have had little real touch with salt water, face to face with the manifold relations between man and the sea. Our University, which formerly had rather the character of a 'Schleswig-holsteinische Landsuniversität,' has been gradually becoming the marine university of Germany." And it is well known that the first great scientific marine expedition of Germany, the "Planton Expedition," was manned from Kiel. Professor Brandt's words seem to us exceedingly wise, and while we rejoice that adequate recognition is given to the resources of the sea in St. Andrews and Liverpool, to navigation in Glasgow, to bacteriology in London, to geology and good-breeding in Edinburgh, and so on surely all round, we still think that the question may be profitably asked, whether our universities have as yet sufficiently realised the importance of acquiring that local colour which is so strongly justified on scientific and artistic grounds, in short, by common sense.

The Metabolism of the Sea.

PROFESSOR KARL BRANDT speaks hopefully of the progress of research in regard to what may be called the metabolism of the sea. The long-continued observations by chemists and biologists have given us some sort of picture of the circulation of matter in "agriculture," and the same is being attempted for the much vaster areas of "aquiculture." The careful studies made by Susta on the carp of the fish-pond and

the ambitious plankton statistics of Hensen and his colleagues are two widely separate instances of the many-sided attack which is being made on the problems of "Stoffwechsel" in aquatic life.

In his address, Professor Brandt has naturally much to say concerning nitrogen, and, at the risk of being trite, we may summarise his general argument, so that the point of his final suggestion may be made clear. The sources of nitrogen available for plant-life are nitrates, nitrites, and ammonia, to which must be added the nitrogen of the atmosphere in so far as that may be brought into available form by electric discharges and by help of the symbiotic fungi in the root-tuberclcs of Leguminosae. From these simple raw materials the plants elaborate the albuminoids which form the fundamental nitrogenous supplies of animal life. On the death of the animals part of the nitrogenous material becomes by putrefaction again available as food for plants. Bacteria affect the circulation in two ways:—on the one hand, over the whole earth there are nitrifying bacteria by help of which ammonia becomes the origin of nitrites and nitrates; on the other hand, there are denitrifying bacteria which effect the reduction of nitrates and nitrites, so that ammonia results, and also some free nitrogen which passes out of the circle of life. So it is in dry land, and so in the sea. Plants raise inorganic substances to an organic level; animals feed upon and return food to plants; and bacteria affect the circulation of matter in two directly opposite ways. The land is always losing nitrogenous substances to the sea, and the only known ways in which the land is compensated for its loss are by electric discharges in the atmosphere and by the root-tuberclcs. This consideration suggests at first sight a possible poisoning of the sea with nitrogenous substances in the course of millions of years; but the suggestion is probably fallacious, since it ignores the action of the denitrifying marine bacteria which destroy any superfluity of nitrogenous compounds in the water, and thus tend to preserve the balance of nature.

After expounding Hensen's plankton-method, to which he attaches great importance as affording a sure statistical basis for physiological conclusions, Brandt discusses two results which are of much interest. The first is, that on the whole the shallow seas are richer in plankton than the deep areas, of which the Sargasso sea, for instance, may be cited as a very sparsely peopled area. The explanation of this is to be found in Liebig's law, that there must be a minimum of each of the eleven or twelve essential chemical elements present if plants are to thrive. In the shallow seas this minimum is secure, for the land is nearer and the area of distribution less vast; in the deep seas the material is so much more widely distributed that the nutritive medium becomes, so to speak, too thin. Apstein has shown that the quantity of pelagic life in lakes varies in direct proportion to the quantity of nitrates present. The second conclusion—perhaps the most striking which has yet resulted from plankton studies—is that the tropical and

sub-tropical seas are relatively poor in plankton, while the arctic seas are relatively rich. How different the terrestrial conditions are, we all know. That plants need light and warmth is also a familiar fact, and yet if Hensen's results are trustworthy we have to face the conclusion that the richest plankton is in the dark, cold arctic seas. Brandt finds a provisional solution of the riddle in the theory that the low temperature hinders the action of the denitrifying bacteria, and that the colder waters are therefore richer than those in the tropics, where the waste of the precious nitrogenous substances is wanton.

The Organism and the State.

BIOLOGY, according to Professor Oscar Hertwig, is pre-eminently the science of the organism, "die Lehre vom Organismus," and as such it has some light to throw on "Sozialwissenschaft," which has the social organism as its central problem. That this familiar thesis should form the subject of a "Festrede" in the University of Berlin may be of value in convincing the narrow-minded that the boundaries between the various sciences are mainly artificial adaptations to intellectual convenience, and that no science can rise to its full dignity in isolation. The address ("Die Lehre vom Organismus," etc. Gustav Fischer, Jena, 1899, pp. 36) is characterised by Hertwig's usual clearness, and its leading thought is this—the problem of the organism has been attacked by three methods, each essential and each partial; there is the method of chemical analysis, the method of physical analysis, and the method of "anatomical-biological" analysis; the first shows us the organism as a "tourbillon" of chemical molecules, the second reveals a series of transformations of energy, but the third method is necessary if we are not to lose the gist of the whole matter that the organism is a unified organisation capable of effective response to the order of nature. Devotion to one particular line of analysis has in the history of biology often led to partial truths which have been errors; it behoves us to seek to free ourselves from such partiality, and not for the sake of biology only, but because of its relation to social science.

A Tail in place of a Head.

THERE is a certain fascination in the subject which Professor Weismann discussed in our last number. The phenomena of regeneration are often surprising and sometimes quaint, and the interpretation of them as adaptive gives pleasing scope for ingenuity. Whether this interpretation, which Weismann has so powerfully defended, be correct or not, time will show; meanwhile each fresh fact is a gain, and one of

the last put on record is that of an earthworm regenerating a tail in place of a head. We are wrong, however, in calling this a fresh fact, for it was observed by Spallanzani in 1768, and is now confirmed by Professor T. H. Morgan (*Anat. Anzeig.* 1899, xv. pp. 407-410, 9 figs.). We have often admired the "expeditiousness" of American workers, but when Mr. Morgan tells us that he began in October 1899 a new series of experiments, we cannot help regarding it as a little "previous."

In the cases observed many segments were regenerated from the anterior end of a posterior half of a worm, and the new part was a tail, not a head. Sections showed that there was no brain, and that the ventral cord extended into the last (youngest) segments of the new part. Moreover, to the objection that such parts might subsequently develop a brain at the distal end, Mr. Morgan answers that the nephrostomes in the new part are turned backwards, that is towards the old part, and the main part of the nephridial tube lies in the segment distal to the one containing the nephrostome. Therefore what is produced is a worm with two tails turned in opposite directions. It is, if that makes any one any wiser, a case of heteromorphosis.

Regeneration in Starfishes.

MANY naturalists have made observations on the regenerative power of starfishes, but Miss Helen Dean King has advanced our knowledge of the subject by precise experiments (*Arch. Entwickl. mech.* 1898, vii. pp. 351-363, 1 pl.). As Professor Weismann's recent essay has focussed the subject, and as it is important to test his theory by reference to all known cases, it is appropriate here to summarise Miss King's chief conclusions in regard to *Asterias vulgaris*. New arms develop only from the disc; an isolated arm must have at least a fifth of the disc if regeneration is to occur; the aboral surface of the disc may be regenerated; the ventral portion of an arm can regenerate the dorsal surface, but the reverse does not seem to occur. If a starfish is cut in two, each half may regenerate the whole, but there is no evidence that this occurs in natural conditions; moreover, two halves of different individuals made be made to unite. In general, we get the impression that the regenerative capacity in the starfish is well adapted to cover the ordinary contingencies of life and a good deal more.

An Alpine Paradise.

MR. H. J. ELWES, in an interesting paper on the zoology and botany of the Altai mountains (*Journ. Linn. Soc. (Zool.)* 1899, xxvii. pp. 23-46,

6 figs.), gives us a glimpse of a wonderful field for research, within three weeks' journey of England, and yet "practically less known to naturalists than many parts of Central Africa." Speaking of the marshy Alpine flower-gardens near his camp on the Darkoti or Tachety river, 30 miles south-west of Kuch Agatch, at about 7000 feet, he says, "I have never, either in the Alps of Europe, in the Sikkim Himalaya, in Colorado, California, or anywhere else, seen such a perfect natural garden of beautiful Alpine flowers as I saw here in the middle of July. Among the most conspicuous were the lovely *Primula nivalis* Pall., which strongly resembles *P. parryi* of Colorado; *Dracocephalum grandiflorum*, which grew in sheets of caerulean blue; *Polemonium pulchellum*; *Gentiana altaica*; *Pedicularis verticillata*, *P. foliosa*, *P. comosa*; *Allium sibiricum*, or *senescens*, the most ornamental of its genus; *Linum caeruleum*; *Iris tigridia* Bunge; *Pyrethrum pulchellum*; a lovely blue *Corydalis* growing in wet places, which Mr. Baker cannot name, and which may be new; a beautiful *Aquilegia*, named *A. glandulosa* at Kew, but much finer than that plant as we know it in our gardens; several pretty species of *Astragalus*, *Lloydia serotina*; and many well-known Arctic and high Alpine plants, such as *Papaver alpinum*, *Draba ochroleuca*, and *Saxifraga oppositifolia*, which were found as high up as 8500 feet, where the flora and scenery reminded one strongly of the high fjeld of Norway, and *Dryas octopetala*, which covered the curious dry gravelly ridges on the hill-sides in many places." Truly an Alpine paradise.

Regeneration and Development.

IN connection with Professor Weismann's article on regeneration in the last number of *Natural Science*, it is of interest to call attention to a "Rectoratsrede" by Professor H. Strasser of Bern, entitled "Regeneration und Entwicklung" (Gustav Fischer, Jena, 1899, pp. 31, 1 mark). In this interesting address a comparison is made between the phenomena of regeneration and those of ordinary ontogeny, and an attempt is made to suggest a compromise between Weismann's position and Hertwig's. It is interesting to see how Strasser's criticism that Weismann attaches too little importance ("eine allzu untergeordnete Bedeutung") to the interactions of parts and the influence of external conditions has been met in Weismann's recent article, as on p. 322: "I may, indeed, have laid too little emphasis on the rôle of the liberating stimuli, and bestowed my attention too exclusively on the 'Anlagen' . . ." Or, again, "It will probably be necessary to make a compromise between the theory of dispersal and that of liberation, though it may not yet be possible even to sketch its outlines with certainty."

The Bipolar Hypothesis.

PROFESSOR D'ARCY W. THOMPSON has subjected the so-called "bipolar hypothesis" to careful scrutiny and has found it wanting. In the introduction to his paper (*Proc. Roy. Soc. Edin.* 1898, pp. 311-349) he points out that Theel was one of the first to suggest that a peculiar likeness exists between the northern and southern extra-tropical faunas, and particularly between those of the arctic and antarctic regions. The suggestion was elaborated by Pfeffer, and has of late been dealt with in great detail, and in relation to the antecedent causes that might have led to such a phenomenon by Sir John Murray. Dr. A. E. Ortmann and Professor C. Chun have both pronounced against it, the latter believing that the occurrence of a small number of forms common to far northern and far southern seas may be sufficiently accounted for by the continuous distribution or gradual intermixture of forms in the depths of the intervening oceans under present conditions, without our needing to have recourse to an explanation of the phenomenon in the different conditions of a former age.

Professor Thompson's analysis "shows that of some ninety species quoted by Murray as common to northern and southern localities while absent from the intermediate zone, there are more than one-third in which grave doubt as to their identification was expressed by the original describers, or in which the identification has been doubted or denied by later writers.

"In somewhat more than another third the evidence of identity is inconclusive or even inadmissible by reason of the nature of the examination to which the specimens were subjected (as in the case of the horny and calcareous sponges), or by reason of the small size of the objects and lack of adequate marks of characterisation (as in the case of the minute ostracod and molluscan shells).

"Of the remaining forms about a dozen find their northern representatives in the Japanese seas, where they form part of a fauna predominantly southern in its relations, and where at least the occurrence of any particular form cannot be taken, *ipso facto*, as evidence of a boreal centre of distribution.

"Both these last forms and the remnant of equal number that are quoted as occurring in the North Atlantic, as well as in or near the Southern Ocean, are for the most part deep-water species, and have in a large proportion of cases peculiar characters of their own. We cannot say at present that they are forms characteristic of any particular geographical province, and their specific area of distribution has in some cases been greatly extended since the date of their original discovery."

We have quoted the above paragraphs since the problem is one of great interest and importance, and to show that the indictment of the hypothesis is a heavy one. The author proceeds to point out that the

bipolar hypothesis has been rejected by Professor Herdman for the Tunicates, by Professor Ludwig for the Holothurians, by Dr. Ortmann for the Crustaceans, and that his own analysis has not revealed a single species of fish, of Decapod, of Isopod, of Amphipod, which inhabits at once the arctic and antarctic oceans.

He admits that the "bipolar hypothesis" might still find support if it could be shown that similar and truly allied forms gave to the two regions a common facies. But of this he finds no convincing evidence.

Eocene Sharks and Skates.

THE Selachian fauna of the Eocene period is very imperfectly known. There are a few complete skeletons in the fissile limestone of Monte Bolca and Monte Postale in Northern Italy, and a nearly complete skeleton of *Xiphotrygon*, which was described by Cope, from the Green River marls of Wyoming. In other localities they are represented merely by portions of dentition, detached teeth, cartilage, or vertebrae. As, however, detached fragments are not always distinctive, and the generic or specific assignation of them is little more than guesswork, we are unable to restore the Eocene Selachian fauna from present materials; Mr. Smith Woodward, however, in the *Proceedings of the Geologists' Association* for February, has brought together the available evidence from British deposits, and placed it on record in the hope that further search may lead to better material and more accurate knowledge. A plate of fossil teeth accompanies the paper.

Radiolaria in Devonian Rocks.

THE discovery that Radiolaria were to be found in the older cherts has been taken up and worked for all it is worth by Dr. J. G. Hinde, who has again contributed a paper to the Geological Society. The present specimens come from the district of Tamworth, New South Wales, and are found in siliceous limestones and volcanic tuffs. Those in the tuffs are better for study than those in the limestones, because they occur more isolated. At present the hunting of fossil Radiolaria seems highly exciting, and comparable to that of insects, for every one found appears to be a new species, and provides for endless ingenuity in the coining of new names. But, as Dr. Hinde truly says, "our present knowledge of Palaeozoic Radiolaria is limited to those occurring in a few outcrops in Central and Northern Europe," and so rounds off his fifty-three new specific names.

Foraminifera of Borneo.

An interesting and important paper on the orbitoid and nummuline Foraminifera of Borneo has been published by Messrs. R. B. Newton and Richard Holland in the *Annals and Magazine of Natural History* for March. The paper should be of especial value to those who are at present unravelling the age of the rocks of various coral islands, the bulk of which have to be studied as thin sections. The authors have shown a wise discretion in not instituting numerous new species, so easy from the deceptive nature of sectional material. The one form described as new is *Orbitoides (Lepidocyclina) verbeekii*, whose distinctness was only established after careful comparison. It is interesting to see another identification of Schlumberger's genus *Linderina*, first described from the Upper Eocene of Bruges (Gironde). The material dealt with was provided by the late Mr. A. H. Everett and by Professor Molengraaff, now of Pretoria. The type of *O. verbeekii* is founded on Brady's *O. papyracea* (1875), and the specimens are partly at Cambridge and partly in the British Museum.

On Ciliary Movement.

In the northern city in which the editorial and publishing offices are now placed, the inhabitants not infrequently complain of the excess of water which pours down from our too liberal skies, but it does not often happen that we are absolutely drowned out of house and home. This sad calamity has now overtaken us, and, dripping and disconsolate, we are left to survey the ruins of what was lately a snug sanctum. But the impatient reader may ask what the editorial woes have to do with ciliary movement. The answer necessitates a short explanation. Professor Herrera has recently sent us an apparatus to illustrate a paper ("Explication du mouvement vibratile," *Mem. Soc. Alzate*, x. p. 322) which he has just published on the causation of ciliary movement. In the apparatus a stream of water is employed as a substitute for the osmotic currents which the author believes to be the prime cause of the movements of living things, and the Professor urged us strongly to attempt the experiment for ourselves. The apparatus, it may be well to explain, consists of a large artificial cell furnished with numerous short rubber tubes representing cilia, and a large tube by means of which the stream of water may be introduced into the cell. The directions informed us that when the large tube was fixed to a tap, and the tap turned on, the small tubes would vibrate rapidly. Full of faith and enthusiasm we made the experiment, the office boy assisting with a devotion which his legitimate work often fails to inspire. We regret that we are unable to give a clear account of the

movements of the cilia, or to speak of the theoretical bearing of the results, but we can honestly certify that as a douche the apparatus is of the highest practical value. We have no wish to throw cold water upon Professor Herrera, but we would like to mention that he certainly performed the operation very successfully upon us. Indeed, when once again the editorial person was restored to comfort and dryness, a sudden suspicion flashed upon us that perhaps the instrument had been tampered with in transit, and that some enthusiast, too hardly treated in these pages, was now avenged, having successfully returned *quid pro quo*.

The Justification of Sea-Fish Hatching.

THE recent rapid development both in this country and America of the practice of artificial hatching of sea-fish eggs, has, naturally enough, raised up critics who question the economic value of the process. In the "Report for 1898 on the Lancashire Sea-Fisheries Laboratory," Prof. Herdman devotes several pages to a consideration of one of these criticisms. His paper is of much interest, especially when taken in conjunction with the account given elsewhere in the report of the work done at the hatchery at Piel. The critic, Mr. Fryer, in the "Twelfth Annual Report of the Sea-Fisheries Inspectors for England and Wales (1898)," discusses the methods and results of American hatcheries as disclosed by their annual reports, the discussion tending to disprove the usefulness of sea-fish hatching in general.

As to methods, special emphasis is laid on one point. It is well known that two plans have been adopted to obtain eggs for hatching purposes. The one, that hitherto practised at Piel, consists in obtaining spawning fish from trawlers, or floating eggs from the surface; the other, as practised in most of the older stations, consists in keeping mature fish in captivity in spawning ponds until they breed. Mr. Fryer argues strongly in favour of the former course, urging especially that there is every reason to believe that the captive fish breed more rarely and produce fewer ova than they would under natural conditions. In other words, he argues that however successful the hatching operations, the resulting fry are far less numerous than they would be under natural conditions. On the other hand, Prof. Herdman points out that the work at Piel has proved, if indeed it needed to be proved, that the difficulties in the way of collecting eggs from trawled fish are so great as to reduce the chance of successful hatching almost to a minimum—experience shows that a spawning pond is an indispensable adjunct to a successful hatchery. Further, as Professor Herdman shows, Mr. Fryer's argument fails to take account of the heavy risks of elimination to which breeding fish, ova, and fry are alike subjected in natural conditions. So convinced is

Prof. Herdman of these dangers that he believes that fish-hatching may be justified "even if not a single individual out of the millions of fry set free ever lives to become adult," for the additions of these millions to any area must greatly diminish the risk of destruction of the naturally hatched fry. There is, however, one point which Prof. Herdman does not mention which has been dwelt on by other critics, and which is again suggested by the results at Piel. As in many other cases it was found impossible to induce the larvae to feed. Even in the most successful cases they gradually diminished in vigour as the yolk disappeared, and ultimately died without ever having taken food independently. The curator suggests, as has been done by others, that it will probably be better another year to free the larvae before the yolk is completely absorbed. The obvious difficulty presents itself that there is no *proof* that the larvae are more likely to survive in the open sea than in the hatchery; some observers indeed believe that such larvae suffer from a form of anaemia likely to be as fatal in the open sea as in the hatchery. Will such larvae be of value even as food-supply to the enemies of the naturally hatched fry? On the whole it does not appear that we can go further than to say with Prof. Herdman that marine fish-hatching is still in the experimental stage. He believes, however, that the results so far obtained are sufficient to encourage workers "to continue the work vigorously in a hopeful spirit and with an open mind." There can, we think, be no doubt from the report before us that, whether the Laboratory be as yet economically justified or no, it certainly justifies its existence from the scientific standpoint, and though we know that the scientist is not concerned to show that his work has always a practical outcome, yet it may not be amiss to repeat that experience proves that one cannot tell where or when such practical outcome may be manifested. Indeed, the results here set forth of investigations on mussels and oysters, on plankton, on the food of young fishes, and so on, are laying a foundation upon which scientific aquiculture may one day be built.

"Symphily."

THE word "Symphily" may sound like a conundrum to many learned naturalists, but we are not responsible for more than the last letter of it. In its German form "Symphilie" it is used by Wasmann and others as a convenient term for the custom many ants have of showing liberal hospitality to various other insects. Unlike the cuckoos, who leave parental responsibilities to be discharged by proxy, not a few ants seem to have a positive mania for adoption. In fact, they indulge in hospitality to their own disadvantage, for at least some of the guests which are adopted in youth become curses to their foster-parents. In

this Wasmann finds an argument against the theory of natural selection which has fostered a custom or instinct of a disadvantageous sort. But this argument surely implies an altogether fallacious assumption, that this is the best of all possible worlds. No one can believe that natural selection has worked out an ideally perfect *modus vivendi* for any organism; what is worked out is a practicable compromise between the organism and the order of nature. A strong parental instinct has been evolved in ants; it is not perfect any more than any other parental instinct; it has the defects of its qualities; and the guests are really, as Escherich and Janet maintain, parasites on a virtue, illustrations, in short, of the familiar biological fact that there is no rose without its thorn.

The Jermyn Street Museum.

THE Government has decided not to remove the Museum of Practical Geology from Jermyn Street to South Kensington. There has been a good deal of feeling over the matter. For our part we think it would have been well to place the fossils at Jermyn Street alongside of those at the British Museum. It would have many advantages. To attempt to name fossils now, under the same conditions that prevailed half a century ago, is disheartening to any worker, and it seemed desirable that the Geological Survey should pay a little more attention to economic geology, for which purpose the Museum of Practical Geology was undoubtedly founded.

Science and Literary Style.

WE have received from Mr. Buckman a protest against the condemnation of his Homeric adjectives implied in our criticism last month of his article on Cycling. We admit that the question of the exact number of adjectives which the English noun may be induced to bear, is one which may be justly submitted to arbitration, but we still retain our original opinion that the specimens we quoted were instances of excess. It seems to us also too much that one poor substantive of five letters should be compelled to stagger under the weight of two such adjectives as "draggle-tail" and "limb-hampering," however justifiable these might have been in an earlier and more heroic age. Mr. Buckman—if we do not misunderstand him—is of opinion that the accumulation of adjectives, preferably of the compound type, conduces to intelligibility, and that this intelligibility has a price far above the rubies of literary style. We must admit that this opinion seems to be justified by much scientific writing of the present day.

Mr. Buckman says further that we have misunderstood him in some other respects, but we can do no more than refer our readers to the original paper which is now completed, and which will be found full of interest and instruction.

Welwitsch's Collection.

THE Trustees of the British Museum have just issued a third part of the account of the plants collected in Angola by Dr. Welwitsch. Like Parts I. and II. (already noticed in *Natural Science*) it is the work of Mr. Hiern, and carries the account of the Dicotyledons from Dipsaceae to Serophulariaceae. Nearly half the book is occupied by the great order Compositae, of which 80 genera find representatives in the flora of this strip of western tropical Africa. According to Welwitsch's own estimate the proportion of Composites was in Angola proper about a sixteenth of the total number of species of seed-plants. Further south, in Benguella and Huilla, it was one-ninth or one-tenth, thus approaching nearer to that prevailing in the Cape flora, where the plants of this family reach their highest proportion. In the primeval forests of the mountains several arborescent species occur, and various small trees and shrubs supply the natives with tonic-bitter barks for use in cases of fever and diarrhoea. A species of lettuce in Loanda affords an excellent salad. By the incorporation of Dr. Welwitsch's copious notes the work has a general interest not usually associated with a technical systematic treatise. It will be news even to most botanists that the genus *Strychnos*, which gives us the deadly *Nux Vomica*, furnishes also "well-tasting fruits resembling oranges, and called by the natives *Maboca*," under which name several wholesome and common species of fruit are known, "especially in the interior of Huilla, where at their proper season, in December and January, the natives can buy from two to four dozen for a cotton handkerchief or a sheet of white paper."

In nomenclature Mr. Hiern follows Dr. Kuntze, and sometimes rejoices in outdoing his master. He has rediscovered several names of genera which by law of priority must replace those hitherto accepted. For instance, *Marsea*, *Detris*, *Elichrysum*, and the less euphonious *Crocodilodes*, all restorations from Adanson, will not be familiar to workers on Compositae, while *Pacouria*, founded by Aublet in 1775, must replace *Landolphia*, which did not see the light till early in the present century, as the name of the well-known rubber-producing genus.

The numerous specimens cited, the considerable proportion of new species described, and the great number of species hitherto known which are recorded, will impress the botanist with the untiring industry of Dr.

Welwitsch, his eminence as a careful and scientific collector and the great value of his collections, in the possession of which the British Museum may well feel proud. It is also matter for congratulation to all concerned that the parts of the catalogue follow each other at such short intervals, thus giving the promise of a speedy completion of the work.

American Mammalogy.

THE first twenty-five pages of the January issue of the *Proc. Biol. Soc. Washington* (vol. xiii.) are occupied by papers on mammals from the pens of Messrs. Bangs, Merriam, Miller, and Palmer. Most of the matter in these communications is devoted to the never-ceasing descriptions of new species and sub-species, and the usual edifying controversies and arguments on nomenclatural questions. Mr. Miller's paper on the naked-tailed armadillos, for which the name *Tatoua* is stated to be the proper title, is, however, of more than ordinary interest; and perhaps some of our readers may like to know that such a familiar name as *Orca*, for the killer-whale, has, according to the strictest rules of nomenclature, no right to stand.

Flame Cells in Rotifera.

MR. J. SHEPARD has written an interesting note on the structure of the vibratile tags or flame cells in Rotifera in the *Proceedings of the Royal Society of Victoria*, vol. xi. (N.S. pt. ii. p. 130). He describes the tag as a flattened funnel, closed at one end by a protoplasmic mass, to which is attached an undulating membrane, lying within the funnel, and two flagella as first seen by Rousselet (or one), playing freely outside in the coelom. He regards the appearance of the bundle or row of long cilia as due to a combination of the effect of the undulating membrane and the structure of the side walls of the funnel, which he describes as a striated membrane. Moxon, in 1864, noted the appearance of rows of waves passing along these side walls, and the appearance is familiar. Mr. Shephard notes, in addition, that by careful focussing a face view two such wave rows can be seen, one above the other; and this is his only evidence for the "striated" membranous wall. There is no necessity for this assumption. For if a row of cilia or undulating membrane vibrate, its face view will appear as a set of waves at the "loops" where it most closely approaches the wall, while the intermediate parts will be less visible; and if the optic angle of the lens be high enough to give a sufficiently thin optic section, the loops at the one side will come into view at a different

focus from those at the other. There is consequently no need to assume that the two layers of waves are due to two striated membranes.

Again, the question of undulating membrane or row of cilia is of no real importance; in a large number of cases undulating membranes have been proved to be simply agglutinated cilia, often separable on death. Of such nature are the comb-plates of Ctenophora, the membranellae of the disc in some Rotifers, and those of Ciliata. The distinction is not a strong one.

The details given are interesting and well put.

Plant Embryology.

In the March issue of the *Botanical Gazette*, Prof. D. H. Campbell makes a further contribution to the embryology of the monocotyledons. A study of the embryo-sac of *Sparganium* reveals an enormous development of the antipodal cells after fertilization of the egg-cell. Hofmeister many years ago called attention to the conspicuous antipodal cells of certain grasses, and showed that the number might exceed the three usually found in angiosperms; and more recently Westermaier has pointed out that in the maize and others this exaggerated group of antipodal cells functions as endosperm in early stages of development of the embryo. Koernicke mentions thirty-six as an outside number, but Campbell finds in *Sparganium* more than a hundred cells, or in older stages a hundred and fifty. He suggests that these resemblances may imply a closer affinity than has hitherto been supposed between *Sparganium* and the grasses.

Another plant studied was *Lysichiton kamtschatcense*, an aroid inhabiting North-East Asia and the Pacific coast of North America. Here again the antipodal cells show an unusual development but in size rather than number. There are probably never more than ten, but they become extremely large and the nuclei reach enormous proportions. Their appearance is quite different from those of *Sparganium*, and indeed of any other known angiosperm; they most resemble certain Compositae such as *Senecio* and *Aster*, in which numerous antipodal cells have been described, and also a continuous endosperm, another feature of the embryology of *Lysichiton*. We cannot, however, regard these resemblances as indicating any systematic affinity. Professor Campbell has studied the embryology of other members of the order Aroideae and hopes soon to publish a full account of the results of his work.

ORIGINAL COMMUNICATIONS.

Evolution and the Question of Chance.

By F. W. HEADLEY.

PROFESSOR WELDON has shown that in shore-crabs the dimensions of the carapace vary in accordance with the law of chance, and that the variations group themselves nearly symmetrically on either side of the mean. There is a large number of individuals slightly above the mean, a large number slightly below. Measurements and observations of other animals and of plants brought out similar results. If, therefore, an increase in any particular dimension is of advantage, there are many individuals in which this favourable variation is found, and, if it can be proved that their slight superiority makes the difference between survival and non-survival, then, it is maintained, all is plain sailing, and evolution pursues its way on strictly Darwinian lines. But is not this too large an inference to draw from the facts? Surely there still remains a great deal in evolution to be explained. Indeed, the main problem seems to me still to present itself without much alteration. It is one thing to explain the gradual enlargement or diminution of a particular organ, it is another to account for the various kinds of organs and for the various faculties that animals have developed. To take an instance, Prof. Weldon has proved that the frontal breadth of shore-crabs varies, and by experiment he has obtained evidence suggesting that the survival of an individual depends on its breadth in this region. But this hardly helps us to solve the problem why crabs have developed a chitinous exoskeleton instead of some other kind of cuticle. Are we here also to appeal to the law of chance and say that an unlimited number of kinds of external cuticle were available; that thousands of variations, each offering a different kind of integument, made their appearance; and that this particular kind of chitinous covering was selected in the case of crabs? It will be at once apparent that the law of chance as explained by Prof. Weldon—the tendency of variations to fall on either side of a mean—has no application in a case such as this when the question is one not of amount but of kind. It is true that all variations are due to chance, in the sense that we cannot

know the cause of any particular variation. Darwin, as may be seen by reference to the opening paragraph of the fifth chapter of the "Origin of Species," meant no more than this when he attributed variations to chance. He did not renounce the attempt to find law and system running through animal variability. For in his "Animals and Plants under Domestication," he writes at length upon the "laws of variation," upon "correlated variability," and on the "continuity of variation." He spoke of variations as "spontaneous," meaning that he could not trace them to a definite cause. But he strove to discover the laws which these spontaneous variations obeyed. Obscure as the subject is he has not left it in complete obscurity. The object of this paper is, if possible, to throw some further light upon it.

Even though we should be unable to discover any regulating principle, it is difficult—for me impossible—to allow free play to chance after tracing the development of a chick through its regular stages. Are we to suppose that the organism, roughly but truly, recapitulates its phylogeny, goes through a series of definite phases and at the end of the prescribed course is at liberty to break out into wild haphazard developments? Law and order so perfect surely never ended in chaos. Nevertheless, even if variations were chaotic with no guide but mere chance, if any animal might produce any kind of new organ, and if any existing organ might be moulded to any new form, even then, given an unlimited number of individuals in a species, mere chance might produce a sufficient number of representatives of some new type to form a new species. But the great results achieved by breeders of cattle, horses, pigeons, and other animals have been attained in many cases with quite small numbers. When breeding for some particular point, they have been generally able to find two animals among the few at their disposal in which this was prominent. The smallness of their resources and the greatness of their achievements put it out of the question that they have worked with nothing but chance to help them. If it were a question merely of more or less, then we might call in the doctrine of chances as expounded by Prof. Weldon. But how is the hood of the nun pigeon a question of more or less? In the wild rock dove or in the common dovecot pigeon there is no such growth of feathers in a rudimentary form. Game-fowls occasionally have as many as five spurs. In some breeds particular feathers show particular markings. In these cases we have new departures, not a gradual increase or decrease of an existing organ. Turning to wild animals we find problems of the same kind. There was a time when stags had no horns. The first development of these cannot be put down to deviations on either side of a mean in accordance with the law of chance. Before the horns originated, obviously there was no room for the working of the principle. When once they have come into existence, then their further development can be accounted for on the principle which Prof. Weldon has explained. Take a feather as

another example: it is a scale, but a scale that has been much divided and very highly elaborated. Is it possible to believe that by a process of mere addition a reptilian scale could become a feather? The plants from which our garden flowers are descended had themselves no flowers. The petals are no doubt leaves that have gathered in a whorl and changed their colour. But here again we have a change which cannot possibly be represented in terms of more or less. Parenthetically I may remark that I leave out of consideration the Lamarckian view. The idea that the crawling of bees or other insects over plants, or anything in the environment can have produced flowers is too great a strain on the credulity of an ordinary man. To me every acquired character is, as Weismann has put it, "simply the reaction of the organism upon a certain stimulus." Two more instances and I will leave this part of the subject. The whalebone that hangs from the whale's palate is a fresh development. It cannot be accounted for on Prof. Weldon's principle. In some fishes the air-bladder has been turned into a lung and an entirely new connection has been formed between it and a pair of aortic arches. Here, as in the preceding case, we have a new departure.

I am quite aware that if we hold that no discontinuous variation ever leaves its mark, but is swamped by inter-crossing, there is no such thing as a new departure. But discontinuity is a matter of degree. If we say that only infinitesimal variations can survive, we stultify ourselves, for such variations must be too small for natural selection to work upon. We must, therefore, recognise some amount of discontinuity, and the only question is, how much? I cannot here discuss the point at any length. But if, for instance, the growth of whale-bone was at the outset very minute, it is difficult to see how it could have been of any use, or have had selective value. In colour we know the shifts are sudden. There is a sudden appearance of albinism. Young domestic pigeons are sometimes quite different in colour from either parent. Wild-flowers when planted in a garden will often show some sudden conspicuous variation. However small the bloodvessels connecting the aorta with the swim-bladder turned into lungs, the connection at any rate must have been complete at the outset. For what would be the use of a vessel that communicated with nothing? However we may seek to minimise it, we must recognise some discontinuity, and in some cases some considerable amount of it. That being so, we recognise new departures. And if we recognise new departures, we cannot hold that evolution depends only on deviations from a mean.

If the law of chance fails us in many cases, where are we to look for guidance? I believe that Eimer has discovered where it is to be found. In his "Organic Evolution," p. 52, he says: "I assume with him (Nägeli) that the conditions for a progress towards the more complex, and towards division of labour, exists in the fact that

*a higher stage once reached can afford a foundation for one still higher*¹ since the former, the existing stage, will necessarily be the starting-point for further modification." When reading his book some few years ago, I passed over this passage, failing to realise its importance. Now, having arrived at the same position independently, or, it may be, having recurred unconsciously to what I read there, I look upon the principle which Eimer enunciated as the clue to much that is otherwise inexplicable in evolution. We see everywhere in the organic world order and symmetry: hence it is difficult not to infer that the course of evolution has some better guide than mere chance. Some biologists find in external conditions, and in the creature's own activities, guidance sufficient. But the influence of the environment cannot shape a flower or thistle-down, or the samara of the maple. Nor in these cases can exercise have anything to do with the matter. We must find the guiding principle, then, in the organism itself, for there is no third alternative. Are we to say, then, that the first unicellular creatures contained in them *in parvo* all the complex animals and plants that have since arisen? That is unbelievable. But there remains Eimer's principle. As I understand it, it is this. Each step in advance decides within certain limits the next step. A few examples will make this plain. I take any genealogical tree, Haeckel's for instance ("Evolution of Man," vol. ii. p. 188), which is generally acceptable enough for our present purpose, though, no doubt, every biologist would prefer to draw out his own tree. Nearly at the base we find amoebae, one-celled organisms with a nucleus. Even at this very early stage there are very marked characteristics, notably cell-structure and multiplication by fission. If evolution is to proceed much further, there must be increase in size. Now the character which evolution has already impressed upon the amoeba allows of this only by one method. When fission takes place, the resultant cells may cling together, and then we have one of the Metazoa or multicellular organisms. Take now a point more than half way up the tree, where the Selachii, primitive fishes, are found. From these we find branching off the various kinds of fishes and the amphibians. Should the former course be followed there are paths leading towards the ganoids, the osseous fishes, and the mud-fishes. But development on amphibian lines, when once another alternative has been chosen, has become an impossibility. It is true there may be retrogression, but nature deprecates this, and even if a species retraces its steps it does not retrace them very far. This being so, every advance may be looked upon as a point gained. Every advance cuts off certain possibilities, and opens up certain others. The process may be compared to the system of case law, in which the interpretation of the law by a judge, at any rate if upheld on appeal, becomes binding on all judges who have to try similar cases. As we advance

¹ The italics are mine.

upward from the lowest forms of life, we see this principle constantly at work; each species is guided by its own phylogeny, by the course of its own development. Though it may deviate, it must not go beyond certain limits. Thus primitive reptiles had before them at least two possibilities—avian and specialised reptilian lines of development. A species of bird, if it develops further, must modify the avian type, or the type of its own particular order, but it cannot become a reptile. The amphibian type is still further beyond the region of possibility. As we ascend, it will be seen that the lines along which species may develop, though certainly not less in number than lower in the scale, are less divergent one from another. A primitive bird was evidently capable of evolving an enormous number of specialised forms, but the distance between these is as nothing when compared with the distance between the descendants of primitive Protozoa. The more elaborated and complex the species, the firmer the hand with which its own phylogeny guides it.

In describing this limiting principle I may have seemed to be speaking of known forms as the only possible ones. I am far from thinking that. The known species, living and fossil, may be far less in number than those of which we have neither record nor living representatives. I only maintain that *at any particular stage in the evolution of a species the paths open to it are limited in number*. This sets no limit to the number of forms that may eventually arise. For each advance not only leaves behind a number of possibilities, but opens up a number of others. The particular number of variations possible at any stage we cannot of course discover. But there are the following reasons for believing that they are not very numerous. We have seen that for one-celled organisms the only possible way of advance in size is by the coherence of the resultant cells after fission. When we come to the more complex animals we know their various parts are tied together on the principle known as correlation. The subject of correlation is very imperfectly understood. What is known of it enables us to see that the organism is no mere aggregate of units, but that a variation in one part involves a variation in several others. Hence the organism's capacity for variation does not increase so fast as its complexity increases. Of the limitation which we must attribute to correlation there is abundant evidence. There is the experience of breeders already mentioned. They have made many new breeds, and often with only small numbers to select from. To pass on to other evidence of limitation we find among evolutionists a growing tendency towards the view that species, and even larger groups, not seldom tend to converge. In the Arthropoda it is probable, or at anyrate possible, that we have instances of convergent evolution. There is reason to believe that the ostrich and its allies illustrate the same principle; they are probably polyphyletic in origin, and have converged towards one another. The dentition of the marsupial animals, according to

their food and habits, approximates to that of placental mammals of similar habits. The heart of a bird with its four chambers is strangely like the heart of a mammal, and the difference between the avian and mammalian valves between the two right-hand chambers only serves to bring out the similarity of the main architectural features. Here, then, we have two undoubted examples of convergence; several other highly probable instances have already been mentioned. Is such convergence likely, if the number of possible variations is unlimited? In this connection much might be said on the subject of what Darwin called "analogous variations," the phenomenon of two allied species varying in the same way.¹ In some cases it may be possible to see the actual limit of the capacity to vary. I cannot help thinking that we know all the kinds of outgrowth of which the epidermis is capable; that hair, wool, bristles, teeth, the various formations of horny material, scales, and feathers, are the only possibilities. I infer this from the elasticity of the environment—a subject to which I shall soon return—which allows an organism to choose its own method of adaptation. I would set no limit to the possible shapes and positions of such epidermic growths. I am speaking only of the kinds of material available.

Lastly, I would call attention to the *continuity of variation*, to use Darwin's term for it: the known likelihood that among the offspring of parents in which a particular variation has occurred some will vary in the same direction, so that if a flower shows a tendency to doubleness, some of the seedling plants from it are likely to show the same tendency in a greater degree. There are two main principles, then, on which I wish to insist—(1) that there is at any stage in evolution a limit to the number of possible variations, (2) that there is continuity in variation.

The establishment of the former of these two principles introduces another difficulty. If any variation that appears in any animal must be in conformity with the organisation of the animal in question, and if the number of possible variations is thus limited, how is it that adaptations to environment are as perfect as they are? It is the constant cry of Lamarckians that variations are all definite, *i.e.* not vague tentative deviations, but unmistakable adaptations. I cannot myself accept this proposition when thus broadly stated. But, recognising that adaptation is the rule in nature, I wish to show how a consideration of the character of the environment will help to remove the difficulty.

The environment offers to animals all that they require, and lets them take what they want in any way that they may choose. They must have oxygen, but they may get it by whatever means they like. They must have protoplasm for food, but they may adopt any means

¹ See "Animals and Plants under Domestication," vol. ii. p. 348; see also Eimer's "Zoologische Studien auf Capri."

of laying hold of it that suits their own organisation. The contrivances for seizing food are many and various, and with none of them does the environment find fault. For this purpose most mammals use their teeth, the "snake-handed" elephant uses his trunk, the bird his beak and supple neck. The boa constrictor's whole body is used for grasping. The lobster has his claws, and for man there is his hand, that almost perfect grasping implement. The environment is so accommodating that almost any good piece of machinery works well there. When we see a *Kallima* butterfly we are apt to think of the environment as a procrustean mould into which it has had to fit itself: the insect has had to become, we may imagine, like a decaying leaf, or perish. This is true, no doubt, of the individual *Kallima* now. It is not true of the species long ago before it had advanced any distance along its line of development. At that distant date it might have maintained itself by resemblance, not to decaying leaves, but to something else, by "mimicry" of some other species protected by its nauseating flavour, by itself developing a nauseating flavour, by the vigour of its flight, or by its great fertility. In this particular butterfly we must imagine some slight accidental resemblance to a dead leaf at the outset. The perfection of adaptation is due to its proceeding along the line of development it has once adopted. In each generation those were eliminated which were not in this particular point up to the standard of excellence.

In many instances of adaptation there is much to wonder at. There is, on the one hand, the marvellous variability of living organisms, due to causes which we can only speculate upon, and on the other there is the easy-going elasticity of the environment which can find places for so many different types. The variations that an organism may develop are determined by its own character, which character has been built up in the long course of its phylogeny. When a species has proceeded far along its particular line, then the environment may seem to be an exacting tyrant, allowing of only two alternatives—extreme specialisation in one direction, or extinction.

It is not, however, the environment, but the species, which is to blame. It has lost its plasticity. Its own phylogeny compels it to follow a certain mode of life. The environment is as accommodating as ever, but the organisms that make up the species claim to maintain themselves in one way and no other. And such a demand a changing environment may sometimes refuse.

Some Recent Work on the Anatomy of Fossil Plants.

By ARTHUR J. MASLEN, F.L.S.

No plant types are more interesting, and certainly none have yielded more valuable results to the palaeo-botanist during the last few years, than the numerous forms now known which present intermediate characters tending to unite the ferns with the cycads.

These synthetic forms (of which, unfortunately, the reproductive organs are in no case known), have recently been made into a group—the Cycadofilices, and this again may be conveniently divided into two fairly distinct series; the first including such types as *Lyginodendron*, *Heterangium*, *Poroxylon* and *Protopitys*, in all of which the stem is essentially monostelic (containing only a single vascular axis); and the second containing a series of forms, the stems of which exhibit a more or less complicated polystelic structure, well seen in the most familiar forms—the Medulloseae.

The two most interesting monostelic forms, *Lyginodendron* and *Heterangium*, are common in the calcareous nodules of the English Coal Measures, and have formed the subject of the last of the valuable contributions to palaeontology made jointly by the late Professor W. C. Williamson and Dr. D. H. Scott.¹ The material with which these two botanists were able to work was so good, and the preservation of the vegetative organs so perfect, that it was possible to work out the structure in great detail, and to arrive at such certain conclusions as would astonish the botanist unacquainted with modern palaeo-botanical research. To such the illustrations in this memoir (and in others) will be a revelation.

The generic name, *Lyginodendron*, was originally applied by Gourlie to casts of stems exhibiting what is now generally known as the "dictyoxylon structure." This structure, which consists of the presence in the outer cortex of a strengthening tissue, composed of an anastomosing longitudinal network of sclerenchymatous strands, leads to a very

¹ "Further Observations on the Organization of the Fossil Plants of the Coal-Measures. Part III. *Lyginodendron* and *Heterangium*," *Phil. Trans.* (1895), vol. clxxxvi. B. pp. 703-779, pls. 18-29.

characteristic appearance in some of the casts; but, inasmuch as later research has shown that the same structure is common in the outer cortex of many quite distinct Palaeozoic plants, the name *Lyginodendron* lost its generic significance until Williamson adopted it for some specimens showing internal structure, which he believed to be identical with some of the casts to which the name had been originally applied.

Unfortunately, as already mentioned, nothing whatever is known as to the organs of fructification of any of these forms, or, at least, if they are known they have never been correlated with the vegetative organs. "So long as the mode of reproduction is unknown, it will be impossible to assign these genera definitely to their systematic position; in the meantime, we can only weigh with due care such evidence as is afforded by their vegetative structure. This evidence, as we shall show, clearly indicates, as far as it goes, a position intermediate between ferns and cycads."¹

However, the taxonomic value of anatomical characters is gradually becoming more and more recognised. Dr. Scott, in his Presidential Address to the Botanical Section of the British Association in 1896, referring to this, instances the Marattiaceae as an example, pointing out that in this old fern-family there is great uniformity in anatomical structure, while the sporangia show the important differences on which the distinction into genera is based.

Another good example may be found in the Calamites, the structure of which has been worked out with very great completeness by Williamson; and later, by Williamson and Scott.² These later researches have shown that the primary structure of these common Coal Measure fossils, is essentially so exactly that of an *Equisetum*, as to leave no question as to their near relationship, and they have accordingly been placed in the Equisetales. And yet, so recently as the publication of Solms-Laubach's "Fossil Botany" in 1887, we find the Calamites treated of in quite a distinct part of the book from the Equisetaceae, recent and fossil. A most interesting historical sketch of the growth of opinion as to the affinities of the Calamites will be found in the recently published valuable introduction to the botanical study of fossil plants by Mr. A. C. Seward.³

Returning to the Lyginodendreae, in *Lyginodendron* the stele of the stem consists of a central pith, around the periphery of which are a number of distinct strands of primary xylem, external to which is seen, in most cases, a broad zone of secondary wood, the elements of which are arranged with great regularity in radial rows. The primary bundles are distinctly collateral in structure and exhibit a distribution of their elements, which is of the highest importance for comparison with

¹ *Loc. cit.* p. 704.

² "Further Observations, etc. Part I. Calamites, Calamostachys, and Sphenophyllum." *Phil. Trans.* (1894), vol. clxxxv. p. 863.

³ "Fossil Plants," Cambridge University Press, 1898, vol. i. pp. 295-302.

modern forms. It is characteristic of the primary vascular bundles in an ordinary stem for the xylem to differentiate entirely in a centrifugal manner, *i.e.*, for the first formed elements (protoxylem) of the primary xylem to occupy the inner limit of the bundle. But the examination of sections of the stem of *Lyginodendron* at once shows that the smallest first-formed elements of the xylem, lie neither at the outer nor at the inner limit of the primary xylem, but occupy an intermediate position, nearer the outer than the inner side. This being so, it follows that the primary wood has developed both outwards (centrifugally) and inwards (centripetally) from the protoxylem. To this type of structure Solms-Laubach has applied the term mesarch, while Williamson and Scott describe the same structure as mesoxylic.¹

The interest of these mesarch collateral primary bundles in *Lyginodendron*, lies in its comparison with living forms. Until quite recently mesarch bundles were believed to be peculiar to the foliar bundles of Cycadeae, the stem bundles being of the ordinary type. However, in a recent paper in the *Annals of Botany*, by Dr. Scott, we are told that—“The frequency of mesarch structure in the stems of Palaeozoic plants showing unmistakable affinities with Cycadaceae, renders it highly probable that this character formerly extended to the stem, as well as the leaf, of the Cycadaceae themselves. This consideration suggested a renewed investigation of the anatomy of recent cycads, in order to ascertain whether some vestiges of mesarch structure might not still survive in the bundles of the stem.”² Of the axial organs of cycads, however, only the peduncles of certain forms (*Stangeria paradoxa*, *Bowenia spectabilis*, *Zamia Loddigesii*, *Ceratozamia mexicana*, *C. latifolia*) were found to still exhibit the structure in question.

The secondary xylem of *Lyginodendron* (which is present with the rarest exceptions in all known stems) was formed by a normal cambium forming wood internally and phloem externally, and in well-preserved specimens the actual cambium cells are quite evident. In general characters the secondary xylem is quite similar to that of the stem of cycads; it consists of pitted tracheides and ray-parenchyma only, and the xylem is split up into vascular plates only a few tangential rows in thickness by the numerous medullary rays.

Numerous structural anomalies in the stems of *Lyginodendron* have been noted by the authors in the rich material with which they have worked. The most interesting of these variations is that of the appearance of a secondary meristem on the outer border of the pith, and giving rise to wood and phloem with inverted orientation, *i.e.*, with xylem outside and phloem inside. This type of anomaly is exactly that found in the stems of some modern plants, such as *Tecoma grandiflora*, a root-climber belonging to the Bignoniaceae, and its

¹ *Loc. cit.* p. 713.

² “The anatomical characters presented by the peduncle of Cycadaceae,” *Annals of Botany*, vol. xi. p. 401.

occurrence in *Lyginodendron* is regarded by the authors as merely an occasional variation of no specific value. This point is taken as a peg on which to hang a few general remarks on the *indiscriminate* use of anatomical characters. They point out that—"The anomaly in question is known to be of very inconstant occurrence at the present day. Both in the genera *Tecoma* and *Iodes* some specimens show it and others do not, though analogous peculiarities (internal phloem for example), are often characteristic of entire natural orders. Anatomical characters, in fact, like any other characters, are sometimes of great constancy, sometimes highly variable, while the same character which is relatively constant in one family may be most inconstant in other groups."¹ They further point out that—"In the present paper, we have been compelled, in the absence of organs of fructification, to make great use of anatomical characters. We have, however, endeavoured to rely on those which are known to be of great persistency in families which presumably belong to the same cycle of affinities as the plants with which we are dealing."²

The leaf-traces, which pass out from the stele of the stem so very gradually as to have led Williamson, at first, to think they were cauliné bundles, have been shown to be continuous with the peri-medullary strands (primary bundles) around the pith, and many sections show these bundles passing through the secondary wood on their way out to the leaves.

It is a rather remarkable fact that, in all the specimens of *Lyginodendron* which have hitherto been examined, no trace has been seen of branching. Of course the evidence is not conclusive, but not a single branching specimen has yet been detected, since all the supposed branches which have been described have turned out to be either petioles or adventitious roots.

With regard to the petioles of *Lyginodendron*, Williamson long ago surmised that these were identical with his *Rachiopteris aspera*, and the discovery of the leaflets in connection with the branched petiole led to the conclusion that the leaf can be referred to Brongniart's form-genus *Sphenopteris*. We therefore have here the combination of cycad-like stem and distinctly fern-like leaves. But the authors point out that something more is needed to establish filicinean affinities: "The classical case of *Stangeria* is a sufficient warning against any such hasty inference. It must, however, be remembered that in the foliage of *Lyginodendron* we have not only fern-like form and venation, but also fern-like structure, whereas in the case of *Stangeria* a single transverse section of the petiole would be sufficient to prove that the plant is no fern, but a cycad."³ A striking example this of the importance of a knowledge of the internal structure of plants in these investigations! The bundles in the petiole are the typical concentric ones of a fern, while the continuations of the same bundles in the stem are collateral, and have a distinctly cycadean character.

¹ *Loc. cit.* p. 722.

² *Loc. cit.* pp. 722-723.

³ *Loc. cit.* p. 727.

It should be pointed out, however, in this connection, that Dr. Scott, in his recent paper on "The anatomical characters presented by the peduncle of Cycadaceae," already quoted, has shown that in the peduncle of *Stangeria paradoxa*, T. Moore—which shows the mesarch structure and consequent development of both centripetal and centrifugal primary xylem—the small caulin cortical bundles which also occur in the peduncle sometimes exhibit a typically concentric structure. These concentric bundles are of considerable interest, not only as the only recorded cycadean bundles with a primarily concentric structure, but also as probably indicating a recurrence to a condition which appears to be a relic of an ancestral fern-character. To quote Dr. Scott: "The evidence for the origin of cycads from ferns is now overwhelming, Professor Ikeno's discovery of the multiciliate spermatozoids of *Cycas* completing the proof in the most striking manner."¹

Still more recently Mr. Worsdell has described "The vascular structure of the sporophylls of the Cycadaceae,"² and has shown that, exactly as in the case of the peduncle, the sporophylls borne on it retain certain primitive characters which are not found in the foliage leaf. He shows that this primitive character is exhibited here also by the development of concentric bundles which occur in both fertile and barren sporophylls in several genera. "These concentric bundles are absent from the foliage leaves, the structure, number, and orientation of whose bundles are extremely regular, constant and well defined, whereas in the sporophylls the reverse is the case, a fact which probably points to their possessing a more primitive structure, viz. one not so perfectly adapted and stereotyped to subserve a special physiological function, as is the case with the foliage leaves."³

On the outer surface of the cortex in both petiole and stem of *Lyginodendron* are seated some curious emergences, the structure of which suggests a gland of some kind. It was the similarity of these structures on stem and leaf-stalk which first led Williamson to surmise that the petioles (*Rachiopteris aspera*) were borne on *Lyginodendron* stems. Similar appendages are found on some recent tree-ferns, more especially on *Alsophila australis*.

That the fossils previously described by Williamson as *Kaloxylon Hookeri* are the adventitious roots of *Lyginodendron* appears to have been proved almost simultaneously and independently by Williamson and Scott and by the late Mr. Hick.⁴ In the memoir by the two first authors the evidence on which this conclusion is based, and the somewhat peculiar structure of these appendages is fully described. That they are really roots is proved not only by their primary structure, but

¹ *Loc. cit.* p. 409, and *Annals of Botany*, June 1897.

² *Annals of Botany*, June 1898.

³ *Loc. cit.* p. 239.

⁴ "On *Kaloxylon Hookeri*, Will., and *Lyginodendron Oldhamium*, Will.," *Mem. and Proc. Manchester Lit. and Phil. Soc.* (1895), vol. ix. p. 109-116.

also by their endogenous origin; tangential sections through the cortex of the parent plant, and passing also through an adventitious root, showing the latter as a complete organ possessing a cortex and epidermis of its own, whereas a similar section through the base of a branch would show only the vascular tissues passing outwards from the stele of the main stem. The authors point out that—"The typical roots of *Lyginodendron*, before the commencement of secondary growth, often bear a striking resemblance to the smaller roots of recent Marattiaceae."¹

The roots exhibit secondary thickening in a quite normal manner, but curiously enough become more like certain dicotyledonous roots (e.g. *Cucurbita Pepo*) than those of cycads or ferns. The peculiar and characteristic appearance presented by the older roots, in which the secondary xylem shows a peculiar disposition, generally into five or six large wedges, separated from one another by wide parenchymatous wedges, is simply due, as also in the *Cucurbita* mentioned above and figured by De Bary,² to the fact that, whereas opposite the primary phloem groups great masses of xylem separated by narrow medullary rays are formed, thus building up the wedges of wood, opposite the primary xylem the cambium forms mainly parenchyma.

All the specimens of *Lyginodendron*, of which the structure is described by Williamson and Scott, are comparatively small in size (not exceeding about 4 cms. in diameter), while many of the cortical impressions, if they really belong to *Lyginodendron*, represent plants which must have attained the dimension of trees. Mr. A. C. Seward has described, under the name of *L. robustum*,³ the structure of a much larger specimen, of which the diameter of the woody cylinder and pith alone attains 14 cms. The preservation of this specimen is not as good as in *L. Oldhamium* (the ordinary form), but traces of the primary bundles can be seen, as also an internal ring of centripetal xylem, similar to what has been described in *L. Oldhamium* as anomalous wood. The author points out that there is great similarity between *L. robustum* and a type from Autun, described in 1879 by Renault as *Cycadoxylon Fremyi*, and adds that "the term *Cycadoxylon* proposed by Renault, if extended in its application, might serve as a general generic designation for plants possessing secondary xylem closely resembling that of recent Cycads."⁴

In the species of Permo-carboniferous *Poroxyylon* described by MM. Bertrand and Renault,⁵ we find a similar arrangement of parts to that in *Lyginodendron*. They too must have formed small trees. As in

¹ "Further Observations," etc. Part. III. p. 738.

² "Comparative Anatomy of the Phanerogams and Ferns," English Edition, p. 474, fig. 204.

³ "A Contribution to our knowledge of *Lyginodendron*," *Annals of Botany*, March 1897.

⁴ *Loc. cit.*, p. 84.

⁵ "Recherches sur les Poroxylyns," *Arch. bot. du Nord de la France*, 1886. .

the latter genus, the vegetative characters are very completely known, and they approach the cycads even more closely, since here the cycadean type of vascular bundle is found, not merely in the stem but in the petiole also. Moreover, in *Poroxylon* secondary wood was formed in the leaf, and what is still more interesting is the fact that the latter organs (the leaves) appear to approach the familiar Coal Measure forms of *Cordaitea*. On this point Dr. Scott points out that *Poroxylon* is "known only from the Upper Carboniferous, so we cannot regard it as in any way representing the ancestors of the far more ancient Cordaiteae. The genus suggests, however, the possibility that the Cordaiteae and the Cycadeae (taking the latter term in its wide sense) may have had a common origin among forms belonging to the filicinean stock."¹

MM. Bertrand and Renault, however, do not recognise filicinean affinities in *Poroxylon*. "Ils n' ont aucun rapport avec les Ptéridophytes," and they attempt to derive not only *Poroxylon* but *Lyginodendron* and the cycads themselves from the lycopods. But, as Dr. Scott again points out, this view is no longer tenable. Both recent cycads and their fossil allies (Bennettiteae, Lyginodendreae, Medulloseae) abound in fern-like characters, and have simply nothing in common with Lycopods. . . . Recent work has completely confirmed Williamson's original view as to the fern-affinities of these fossil genera."²

Count Solms-Laubach has also described the structure of a somewhat curious ally of *Lyginodendron* from the Culm of Falkenberg, under the name of *Protopitys Buchiana*.³ Here the plant bore distichous leaves, and the central cylinder has the form of an ellipse composed of a large pith surrounded by a thin continuous ring of primary wood, the whole being surrounded by a considerable thickness of secondarily developed xylem. From the extremities of the long axis of the ellipse the petiolar bundles are given off alternately from either end. Solms-Laubach himself considers this type as representing a special group—the Protopityeae, but he is in general agreement with Williamson and Scott in thinking that *Protopitys* constitutes another of the types which are intermediate between the Filicineae and the gymnosperms.

Returning now to the genus *Heterangium*, founded by Corda in 1845, and which has a wider range in time than *Lyginodendron*, and of which the best specimens have been obtained from the Burntisland beds at the base of the Carboniferous system, we have a type which at first sight seems very different from *Lyginodendron*, but which, on closer

¹ *Report British Assoc.*, 1896 (Pres. Add. Botanical Section), p. 1008.

² "The Anatomical Characters presented by the Peduncle of Cycadaceae," *Annals of Botany*, vol. xi, pp. 415, 416.

³ "Ueber die in den Kalksteinen des Krummsteins des Glätzisch-Falkenberg in Schlesien enthaltenen Structur-bietenden Pflanzenreste," II. Abhandlung. *Botan. Zeitung*, 1893, pp. 197-208.

examination, shows many points of similarity, although its characters are altogether more filicinean. Williamson and Scott describe in detail two species (*H. Grievii*, Will. and *H. tiliaeoides*, Will.),¹ of the former of which we now have the most complete knowledge, while the detailed preservation of some parts of the latter is simply marvellous.

This old type differs from *Lyginodendron* mainly in the primary structure of the stele of the stem. There is no pith, but the whole of the interior of the stele is occupied by the primary wood, consisting of groups of tracheae interspersed with irregularly arranged bands of parenchyma. The stem is therefore in general structure similar to that of a typical monostelic fern such as *Gleichenia*. Unquestionably *Heterangium* is much nearer the ferns than is *Lyginodendron*, but it is most interesting to find, when we pass to the structure of the strands of xylem which occupy the periphery of the primary wood, that here again the primary bundles are mesarch, an arrangement which we have already seen to be a cycadean one.

In this case, again, as in *Lyginodendron*, most of the specimens show a zone of secondary wood, which is, however, on the whole, less developed than in the latter genus. The petioles and leaves (which have been identified with *Sphenopteris elegans*) also appear to have been of the same fern-like type, both in form and structure, as those borne on *Lyginodendron*. The root was also quite of the "*Kaloxylon*" type.

In *H. tiliaeoides*, Will., from the Halifax Coal Measures, which received its specific name on account of a resemblance in some points of its anatomy with the common lime-tree (*Tilia*), the tissues are most beautifully preserved. Anatomical details, such as the cambium elements and the sieve-tubes of the phloem, are here preserved, perhaps better than in any other known fossil; in some specimens even the sieve-plates can be recognised with certainty.

Both in *Heterangium* and in *Lyginodendron*, fern-sporangia have been found in association with the remains, though never in actual continuity with them. Nothing in the nature of a cone has ever been found. The authors incline to the view that the material investigated consists entirely of young plants, and in that way seek to account for the absence of fructification; considering that the whole question of the nature of the fructification of these forms is best left open.

All the preceding types have agreed in one important character, that of monostely, there being but one vascular axis in the stem. There is, however, an equally important series of polystelic forms now known to belong to this intermediate group of Cycadofilices. These are mainly known from foreign specimens, most of which exhibit a very complicated stelar structure, and have been known for some years, although Dr. Scott has quite recently described an interesting and very much simpler form (*Medullosa anglica*) obtained from the Lower Coal Measures of this country.

¹ "Further observations, etc." Part III., *loc. cit.*

Most of these types have been put into the class Medulloseae, some of the forms belonging to which were, in the very early days of palaeontology, regarded as Carboniferous palms. Mr. A. C. Seward, in a paper on *Myeloxylon*¹ (now known to be petioles of *Medullosa*) points out that Corda thought it a palm, and Brongniart a doubtful monocotyledon; but the researches of Goepert, Williamson, Weber, Sterzel, and others have shown that the affinities are both cycadean and filicinean. On the whole, Mr. Seward concludes that the fossil specimens are related more nearly to the cycads than to the ferns.

Sterzel and O. Weber² made a very important addition to our knowledge of the Medulloseae by proving that these petioles (*Myeloxylon*) were borne on stems of *Medullosa*. The petioles in transverse section exhibit a large number of vascular bundles encased in a mass of parenchyma, each separate bundle being collateral and having the protoxylem placed on the side turned towards the phloem, the xylem having therefore developed entirely in a centripetal direction, an evidently cycadean character. Sterzel also regards the Medulloseae as having more affinities with cycads than with ferns.

The Medulloseae exhibit, in their stem, a type of structure different from anything known among living plants, and probably represent, as Solms-Laubach has suggested, a divergent branch which has left no descendants among the existing vegetation. They range from the Coal Measures to the Permian strata, and vary considerably in the complexity of their internal stelar structure; the outer surface of the stem being, in most cases, unknown.

The oldest and simplest known form of the genus, *Medullosa anglica*, from the Lower Coal Measures of Lancashire, has been recently described before the Royal Society by Dr. Scott.³ "These fossils are of special interest on several grounds: they are considerably more ancient than any members of the genus previously described; they are the first English specimens recorded; they are preserved in a more complete and perfect form than any others at present known; and lastly, the greater simplicity of their structure causes the essential characters of the genus to stand out with greater clearness than in the more complex species." In some of the specimens the habit of the stem, clothed with overlapping leaf-bases, can be made out, and appears to have been not unlike some of the tree-ferns, such as *Alsophila procera*.

The transverse section of the stem shows the presence of three or four steles, each possessing a pithless xylem strand with the protoxylem elements close to, but not actually at, the periphery (mesarch). Each

¹ *Annals of Botany*, 1893, vol. vii.

² Sterzel, J. T. D. "Beiträge zur Kenntniss der Medulloseae. Nach Mitteilungen und älteren Abbildungen von O. Weber nachträglich bearbeitet," *Ber. Nat. Ges. Chemnitz*, (1896), xiii. pp. 44-143.

³ See *Nature* (1899), vol. lix. p. 381.

individual stele in fact has almost precisely the same structure as the single stele of *Heterangium*, and like the latter develops a cambium and secondary wood and bast, the xylem being of typically "loose" cycadean nature. The leaf-traces, which pass outwards from the stellar system to pass into the leaves, carry with them some secondary wood. As it passes through the cortex, however, the trace loses its secondary tissues and undergoes splitting into a number of bundles, each of which is collateral in structure. The base of the leaf therefore received a large number of bundles, and this distribution of the bundles is described as peculiar and unlike that in any known plants of cycadean affinities.

In other species of *Medullosa* the structure is more complex, there being usually a number of small circular steles occupying the central region of the axis, and one or more larger wavy or annular steles or rings of steles, closer to the periphery, and from which the leaf-traces appear to arise. All the steles exhibit secondary thickening.

A very interesting suggestion in connection with the structure of *Medullosa* has been made by Mr. W. C. Worsdell in his paper on "The anatomy of the stem of *Macrozamia* compared with that of other genera of Cycadeae."¹ The stem of *Macrozamia* (in common with those of *Cycas* and *Encephalartos*) possesses a number of anomalous rings of collateral bundles, secondarily formed outside the normal zone. The tissues in these zones show the normal orientation, having xylem inside and phloem outside; but there is frequently found to be present, either between the normal and the first anomalous ring, or between two anomalous rings, a cambium which develops small bundles with reversed orientation, *i.e.* with xylem outside and phloem inside. In some cases, where the inverted segment lay rather obliquely, it formed an almost continuous zone with the normally orientated segment, thus indicating a tendency towards the formation of a concentric bundle. If these bundles were more completely developed the anomalous zone would be converted into something like what we find in *Medullosa*, steles with xylem internal and phloem both on the inner and outer side. The author says: "The whole structure, both of the anomalous zones and the tertiary cambiums, recalls strongly that of the stem of the Medullosoeae, a fossil group with many cycadean affinities; but it would be rash and premature to suggest here a homology between the two." He gives the suggestion, however, that these anomalous structures are the remnants of some ancient structure once common to a large number of plants, and that this structure consisted of rings or layers of concentric vascular stands.

Evidence has been brought forward by Renault and others to prove that the "Myeloxylon" petioles bore distinctly fern-like foliage, referable to the form-genera *Neuropteris* and *Alethopteris*. Sterzel thinks that *Callipteris*, *Alethopteris*, *Odontopteris*, and *Neuropteris* are

¹ *Annals of Botany*, 1896, vol. x. p. 601.

fronds of Cycadeae rather than of ferns, the absence of fructification lending some support to this view, while Dr. Scott points out that many of the most characteristic forms of so-called fern-fronds from the Carboniferous rocks cannot be accepted as true ferns, but really belong to these intermediate synthetic forms.

We thus see that palaeo-botany, now that it is entering on a stage of its development in which anatomy is taking a leading place, has already yielded positive results, the value of which is only beginning to be recognised by botanists in general. The value of the direct evidence thus obtained may be trusted to throw much light on the phylogenetic history of the groups of living plants, and in no instance is this better seen than in relation with the Cycadeae. That the modern cycads represent an offshoot of a very old cycado-filicinean stock there is no longer any doubt, although the direct links in their phylogenetic history are by no means easy to make out; and this difficulty will remain until much more palaeontological evidence is forthcoming.

In anatomical characters the modern cycads show great variation, and appear to retain many primitive characters, the meaning of some of which is now to a certain extent known. As Dr. Scott points out: "The Cycadales may even be polyphyletic, having perhaps sprung from the Filicineae at various points. The Lyginodendreae, Proto-ptyeae, and Medulloseae all combine Filicinean with Cycadean characters, but they appear to join on to very different groups of ferns."

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A Recent research on Epitokous Forms of Annelids.¹

By PROFESSOR W. C. M'INTOSH, M.D., F.R.S.

FEW subjects in comparatively recent years have excited more interest than the remarkable changes which Prof. Ernst Ehlers of Göttingen first pointed out in the Nereids at the reproductive period. The worms in which these changes occurred were called by Ehlers epitokous forms, while Prof. Edouard Claparède of Geneva termed them epigonous.

Messrs. Maurice Caulery and Felix Mesnil, respectively of Lyons and Paris, have described, in an important recent paper, the results of their observations on a group hitherto unsuspected of harbouring such features, viz., on the Cirratulidae, and more especially on the epitokous phases of *Dodecaceria concharum*, Oerst., a species much more abundant in the south than in the north, probably because the calcareous rocks in which it bores are more characteristic of the French shores and those of southern England, and the growths of *Lithothamnion*, into which it likewise perforates, more luxuriant in these genial waters.

Before entering on the special subject of the epigamy of the Cirratulidae, it may conduce to perspicuity if we take a brief survey of the groups in which these remarkable sexual phases are at present known. No epitokous forms have hitherto been met with in the Amphinomidae, including, for the most part, somewhat sedentary annelids like *Euphrosyne* and *Spinther*; nor is it a prominent feature in the Aphroditidae, the only types that can be mentioned in this connection being *Dreischia* and *Nectochaeta*, pelagic forms the life-history of which is not yet sufficiently known to warrant accurate deductions on the subject. It is possible they are allied to such as *Evarne hubrechti* and *Evarne johnstoni*, forms in which the bristles are much elongated and, in certain examples, the eyes considerably enlarged. Like some other groups of annelids, moreover, the young stages of the Polynoidae are characterised by greatly elongated bristles during their pelagic life, but no reliable deduction as to the connection with the epitokous condition in the adult can be drawn from this feature.

No example of epigamy is known in the Nephthydidae, yet at St. Andrews a form of the common *Nephthys cacea*, O. Fabr., shows a

¹ Caulery and Mesnil, "Les formes épitoques et l'évolution des cirratuliens," 8vo, pp. 200, with 6 plates; Paris, 1899, price frs. 7.50.

characteristic elongation of the bristles in summer, and is found amongst the rocks rather than amongst the sand. So different is the aspect of this form that it has been described as a different species.

In the Phyllodocidae Malmgren describes a *Eulalia* (*E. problema*), from Greenland, in which the middle and posterior feet have greatly elongated simple bristles. De Saint-Joseph mentions two ripe females of *Mystides limbata* which, besides the ordinary bristles, had very long tufts of simple bristles in the middle of the body and also enlarged eyes, absent in unripe individuals. A similar condition is seen in the *Eulalia gracilis*, Verr., of Webster and Benedict. The large-eyed species described by the writer in the "Challenger" volume, however, gave no evidence of a pelagic habit.

In the Hesionidae Malaquin indicates that an epitokous condition occurs in *Kefersteinia cirrata*, and Webster and Benedict describe *Hesione gracilis* as bearing very long dorsal bristles.

The Syllidae, again, offer well-marked examples of epigamy, some at sexual maturity assuming the large eyes, long natatory simple bristles and other characters. In certain forms it is the males only which are affected, in others the females, in which the long natatory bristles are shed after the escape of the eggs. Moreover, these bristles are confined to the posterior region of the body in which the reproductive elements are developed in the form of stolons. In *Autolytus* and allied forms the stolons so differ from each other as to have been included in different genera. An *Exogone*, again, is described by Malaquin which presents now epigamy, now schizogamy (separation of buds). Haswell found a *Syllis* which, while showing eggs anteriorly, developed sperms posteriorly, the latter region developing a head and swimming away as an independent form. While this family, therefore, shows many illustrations of epigamy, it is one in which the most remarkable illustration of branching in an adult annelid occurs, viz. in *Syllis ramosa* of the "Challenger."

In the Nereidae the epitokous condition is a distinctive feature, resulting in the transformation of a *Nereis* into a *Heteronereis*. The external modifications consist in the great development of the eyes, the alteration of the form of the head, and the remarkable changes in the feet, which are complicated by lamellae and foliaceous cirri as well as by modifications of the bristles. The anterior region of the body remains more or less unaltered, but, in the transformed parts behind, the sexual products accumulate. As Perrier aptly says, it is a caterpillar in front, a butterfly behind. Moreover, the males are different from the females.

Some of the finest Nereids, such as the splendidly tinted *Alitta virens* of Sars, are epitokous forms, and the complexity of the changes in such species as *Nereis dumerilii* are full of interest.

No example is yet known in the Lumbrinereidae, but in the Eunicidae, the well-known *Palolo viridis* of Samoa and Tonga in the

South Pacific affords features closely resembling the epitokous or epigamous condition. Regularly, in October and November the sea around the coral reefs of the islands swarms with fragments of the posterior region of these annelids laden with ova or spermatozoa, but without much change in the bristles. So abundant are they that for centuries the natives have collected them for food.

The Onuphidae, Goniidae, Glyceridae, Opheliidae, Scalibregmidae, and Telethysidae offer, so far as known, no examples of epigamy. In the Chloraeidae the authors hint that *Buskiella abyssorum*, M'Intosh, a form apparently intermediate between the Chloraeidae and the Chaetopteridae, and stretching over a wide area at great depths in the ocean, is an epitokous form, an opinion that is hardly warranted by the facts.

The epitokous condition has not been observed in the Chaetopteridae, or in the Spionidae, though the latter in their young stages are amongst the most conspicuous features of the pelagic fauna. It is likewise absent from the Ariciidae.

In the Cirratulidae the epitokous condition is present in *Dodecaceria*, and it may be in others, such as *Chaetozone*, while schizogenesis occurs in *Ctenodrilus*.¹ In the Halelmintidae, Eisig has shown the detachment of the posterior region with the generative products, but without change of the bristles. Nothing of the kind is known in the Maldanidae, Ammocharidae, Hermellidae, Amphictenidae, Ampharetidae, Terebellidae, Sabellidae or Eriographididae, but in the Serpulidae we have schizogenesis.

The epitokous condition thus characterises Polychaets of considerable activity, the only instance in which it is present in a boring or in a fixed tube-making form being in the Cirratulidae, for the Nereids and Eunicids, though they construct tubes, are comparatively active.

The form which the authors have added to the list of the epitokous annelids was originally described by Oersted, and is not uncommon in the northern seas, though our experience of it in Britain is that it is more abundant in the south.

The authors find three well-marked phases in the life-history of *Dodecaceria*, viz. (1) the sedentary atokous, or ordinary form (A); (2) the large epitokous sedentary form (C); and (3) the epitokous pelagic stage (B).

The first-mentioned form (A) is dark greenish-brown, slightly tapered anteriorly and more distinctly posteriorly. The first region includes the prostomium, and the following segments to the 5th or 7th. The prostomium is devoid of appendages, and presents only a pair of ciliated pits. The next segment (the first metastomial of the authors) bears the grooved palps and two branchial cirri. The succeeding segments (generally 5) have capillary bristles, some of those in the ventral division having a tendency to be spoon-shaped. The authors term this region the thoracic, and it bears the branchiae to the number of 5 or 6 pairs. The rest of the body is nearly uniform in

¹ The position of this form is that assigned to it by the French authors.

structure, but the authors incline to subdivide it into two, from slight differences in the bristles; the second from the 15th to the 25th segment. Each segment bears capillary bristles dorsally, and spoon-shaped ones inferiorly. The latter they compare with a similar type in *Polydora* and *Ephesia*. These bristles in the middle or abdominal region are of service to the animal in its movements in the tube, and consequently undergo certain changes from friction.

The authors found a second and large form (C) somewhat resembling the foregoing in April, but rarely, viz. in the proportion of 1 to 100 of the first-mentioned. It measured about an inch and a half. The segments in the middle region are long, while those anteriorly and posteriorly are very short. It is of a pale colour, with two orange-red eyes. The palps are fully developed. Capillary bristles occur in the first 6 segments. From the 7th to the 26th the dorsal fascicle is composed of long pelagic bristles; from the 27th to the 30th of pelagic bristles and spoon-shaped forms; while in the terminal segments it agrees with the previous form. Ventrally the spoon-shaped bristles also correspond with the latter.

In this form a change, chiefly in the pelagic condition of the bristles,¹ the elongation, and less pigmented condition of the median segments, has occurred. The animal is comparatively sluggish, and secretes abundant mucus, in which the eggs may be placed, though none were seen in it. The genital products fill the body-cavity, the ova (for all were females) being yellowish-brown. The segmental organs open between the feet as in form A—at a higher level than those of B. The wall of the digestive tube is atrophied, but to a less extent than in the latter, and the animal takes food.

The third form (B) is the epitokous pelagic one, which differs very considerably from the foregoing, and also from the first form. It was originally noticed by Verrill in the Bay of Fundy, and specific distinction given it—as *Heterocirrus fimbriatus*. This second variety, also rare, is recognised by its great activity, for on escaping from the *Lithothamnion* it swims rapidly through the water like *Nephthys*. It has a more slender form. The central region is enlarged by the genital products, and cylindrical. The posterior region is comparatively small, with a slightly spatulate extremity. The muscles of the body-wall are feeble. The anterior and posterior regions are greenish-brown, the middle bright yellow. The eggs are brownish. The head differs from the typical form (first-mentioned) by the presence of two large eyes, in addition to the ciliated furrows. The anterior region agrees in regard to bristles with the first form, except that they are somewhat longer. The palps, however, are reduced by absorption to mere buds, and the branchiae are short. In the anterior part of the abdomen the spatulate bristles have disappeared, and the greater part of the abdominal region is

¹ The elongation of the setae of the antennae of the ostracod, *Philomedes*, at the period of general maturity, is a parallel instance.

furnished with long swimming bristles, like a pelagic *Autolytus*. These take the place of the bristles described in the first form. Some of the spatulate forms remain, however, posteriorly. The perivisceral cavity is frequented by the gregarine *Gonospora longissima*. This form, therefore, is modified for a more or less pelagic existence.

The authors give an elaborate description, with tables, of the setigerous apparatus and the various modifications it undergoes in the several forms (simple and spatulate). They also append a table of the bristles in the developing forms—from those having one setigerous segment to those with eighteen.

The eggs in the first form (A) are bluish-green, and are set free, as usual, from the ovigerous masses into the body-cavity, from May to the end of summer. Moreover, the authors found trochospheres and embryos of several segments in the coelomic cavity—showing that the form is viviparous. When the embryos are large, their number is few in contrast with the eggs, so they suppose that the larvae are extruded by the segmental organs in successive sets. The authors think that the shedding of the reproductive elements is the end of the individual. They also describe, however, brownish masses about the size of these larvae, which may be degenerating forms in process of removal by phagocytes. Further, the authors consider the form is parthenogenetic, for they have found no trace of sperms or of spermatogenesis. Out of several thousands they observed not a single male. The possibility of impregnation from without is not, however, seriously discussed by the authors. They challenge the opinion of Monticelli, who states that this form is a hermaphrodite protandrous one.

In the second form (C) only a single female approaching maturity was observed in April. The ova are smaller than in A and B, and pass out by the segmental organs probably into mucus, unless this form also is parthenogenetic.

In the third form (B) the sexes were found more evenly balanced, and maturity appeared to be in August. In these the eggs were brownish, and larger than in either of the foregoing. In their pelagic condition the ova and sperms are discharged, and development takes place in the sea, the young forms only returning to the alga when their pelagic life ceases.

So minutely did the authors carry out their investigations that they followed the developing forms of the three series in regard to the modification of their bristles and other parts. Thus, in form A, two eyes appeared in the earlier stages, viz. at 15 segments, and disappeared about the stage with 30 segments. The modifications of the short serrated bristles into the spatulate serrated and the spatulate, the appearance of the palps and branchiae, and the growth of the thoracic and the two parts of the abdominal region of the body are also described as far as the truly adult condition.

Of the second form (C), very few of which, however, were procured,

the authors found no young stages, at least none shorter than 57 segments. They noticed the gradual growth of the eyes, the condition of the mucous glands, and the ova. The spatulate bristles agree with those of the first form (A) in having no process (crochet) at the base of the terminal excavation.

In the third form (B) they had 13 specimens, ranging from 19 to 51 bristled segments. No eyes were present in that with 19 bristled segments, and only a pair of palps and branchiae. In the middle of the body the spatulate bristles were pectinated, whereas posteriorly they had the characteristic tooth below the excavation. They found large eyes in one with 45 segments, and the transformation of the bristles was complete at 46 segments (setigerous). The first 36 pairs of dorsal fascicles showed only capillary pelagic bristles. Those with 51 setigerous segments had the palps reduced to buds. The presence of gregarines in the perivisceral space was diagnostic. It is clear that the bristles of this third form arise by gradual transformation from bristles resembling those of the first (A). B gradually undergoes, therefore, a physiological and a morphological transformation, the well-formed eyes, pelagic bristles, and the atrophy of the palps being associated with the development of the reproductive products. The authors, indeed, divide the process into two stages, a first or preparatory period, and a second or period of transformation. Besides the changes already noted in the second stage, the branchiae show signs of reduction and are friable. The animal ceases to take food, and its digestive canal atrophies (walls become thin), the reserve eosinophile granulations are used up in the development of the reproductive elements in the body-cavity, and segmental organs are developed in all the abdominal segments.

In reviewing their observations on the three forms and drawing conclusions, Caullery and Mesnil consider that the three forms pertain to the same polymorphic species, yet no males have been seen either in the first or second form. Moreover, the latter (C) has been found only in the adult and larger condition, and may be the final condition of the former (A).

The authors review the groups of the Cirratulidae, which they divide into those with and those without large palps. They then descant on the genus *Heterocirrus*, particularly on *H. viridis*, Langerhans, a species having capillary bristles and long hooks, and which assumes an epitokous condition—distinguished by the long swimming bristles, the atrophy of the digestive tube, and the enlarged eyes. A similar condition is met with in *Heterocirrus caput-esocis*, St. Joseph. They also allude to the fixed epitokous condition of *Thoryx marioni*, recognised by the absence of eyes and the long capillary bristles. *Choetozone*, again, is a genus which, throughout all its stages, has the facies of an epitokous form. They also institute a comparison between *Ctenodrilus* and *Dodecaceria*, showing that their external form and internal structure have considerable resemblances. The authors, in fact, consider

Ctenodrilus an arrested representative of the Cirratulidae, such a condition being in agreement with the parasitic life led by some in the coelomic cavity of Holothurians and Synaptae. The gemmiparous condition of *Ctenodrilus* is probably associated with its parasitism.

They consider that schizogamy is derived from epigamy, as Ed. Meyer, Kleinenberg, and Eisig do. On the other hand, Ed. Perrier regards schizogamy as the primitive condition, interpreting, for instance, *Heteronereis* as a colony of two individuals, the metamorphosed region presenting in an aborted condition what is more fully seen in the primitive state in the schizogamous Syllidians. They observe that an annelid normally increases by new segments in front of the pygidium, and they regard as a complication the appearance of a formative region at any other point. In other words, schizogamy is distinguished from epigamy by that addition only, and logically, therefore, the former is derived from the latter.

In some forms epigamy, or the epitokous condition (*Heterocirrus* and *Mystides*), is very simple, viz. the addition of tufts of capillary bristles in a certain number of feet—a primitive modification resulting from a physiological condition, and rendering the animal more mobile when discharging its reproductive elements.

Greater complication is seen in *Exogone* and *Heteronereis*, yet only one region of the body is much modified. Even in *Mystides*, *Heterocirrus*, and *Dodecaceria* (B), the anterior segments do not acquire the pelagic bristles, which occur only in the region behind; and this agrees with the functions of the parts, the anterior directing the movements of the succeeding propulsive region.

In some forms, at sexual maturity, as in *Notomastus lineatus*, Eisig has shown that the abdominal region, charged with the genital products, separates from the thoracic for a pelagic life, yet no morphological change has taken place. A similar condition occurs in *Palolo viridis*, the edible annelid of the Samoans and Tongese.

The authors suggest as a plausible hypothesis that the phenomena of schizogenesis progressively follow schizogamy, by an accelerated embryogeny; as, for instance, in the Syllidians. The consequence of this acceleration is to make the propagation of the species doubly sure, and independent of ordinary sexual reproduction.

The internal modifications of such forms at the epoch of sexual maturity are the rapid absorption of the stored materials, e.g. the eosinophile granulations, the atrophy of the walls of the digestive canal, the diminution of the muscles of the body-wall and its granular ectodermic layer, and the prominence of the segmental organs.

They group the phenomena thus apparent into three divisions, viz.:

1. Phenomena of histolysis without external metamorphosis or scissiparity
 { *Glycera capitata*.
 { *Phyllodocidae*.
 { *Polyopthalmus*.

2. Phenomena of histolysis without external metamorphosis, but with scissiparity *Clistomastus lineatus.*
Palolo viridis.
3. Phenomena of histolysis, accompanied by external metamorphosis (epigamy or epitokous condition), and sometimes by scissiparity (schizogamy) *Heteronereis.*
Cirratulidae.
Syllidae.

They point out the comparative frequency of the epitokous condition in the annelids, and, moreover, that the phenomena of histolysis associated with sexual maturity is very general in the group. Thus there is a close parallelism between them and certain fishes, for instance the salmon, as ably shown by Miescher of Basle, and Noël Paton of Edinburgh.

The fourth chapter of the paper is devoted to a consideration of the various adaptations of annelids for a pelagic life—in order to ascertain what connection the temporary pelagic condition at sexual maturity has with a completely pelagic life. Pelagic annelids may be grouped (1) into those only pelagic at sexual maturity, (2) pelagic larval forms, (3) those permanently pelagic.

Epitokous annelids fall under the first category, and in some their existence is brief, as, for instance, in the case of *Palolo*, which gives an example of pelagic agony rather than a pelagic existence. On the other hand, *Exogone* survives the period of reproduction, and sheds its pelagic bristles.

Most annelids, whether errant or sedentary, have pelagic larvae—generally with long pelagic bristles—and the authors quote Haecker to the effect that these long bristles are not only organs for locomotion, but aid the animal in hovering and other movements. There can also be little doubt that these bristles are—in such as the larval Spionidae—protective, and are used by the larvae very much as the Polynoidae use their bristles when attacked.

The third group, viz., permanently pelagic annelids, is characterised by the transparency of their tissues, large eyes, delicacy and length of bristles. Certain Phyllodocidae, the whole of the Alciopidae, the Typhloscolecidae, and the Tomopteridae (devoid of ordinary bristles) are examples.

The authors conclude that it must at present be admitted that adaptation for a pelagic life may take place independently of the epitokous condition. Indeed, it would have been well if the authors had attended to cases, e.g., the Leeches and Nemerteans, in which active pelagic habits can be assumed without a trace of bristles, and in which the habits are not associated with reproduction, and not always with a permanently pelagic condition. It is the muscular system rather than the bristles which is mainly concerned, and it does not follow that long delicate bristles are better fitted for swimming than for hovering in the water.

The last short chapter contains remarks on viviparity amongst

the Polychaets. The authors cite the peculiar cases of parasitism of one annelid in another, as *Lumbriconereis* in *Marphysa*, one of the Eunicidae. Krohn, however, found a viviparous *Syllis* at Nice, in which the embryos in the body-cavity occupy a third or a fourth of the length posteriorly. Levinson describes briefly a similar instance in *Syllis incisa*. Claparède and Metchnikoff found a viviparous Cirratulian at Naples, the young having two eyes, two pairs of branchiae, and similar touches of pigment to the adult. The authors, as already mentioned, indicate that their form A (*Dodecaceria*) is viviparous, but further observations are needed. Viviparity, again, occurs in *Nereis diversicolor* and *N. dumerilii*. The former, a protandrous hermaphrodite, was found by M. Schultze to produce reddish-brown ciliated pyriform larvae furnished with a mouth and incomplete intestine. The segmentation of the eggs has been seen by Schroder; while Mendthal thinks they may only be exceptionally developed in the interior of the mother. The authors suggest that it may be a case of self-fertilisation. The viviparity of *Nereis dumerilii* was observed by Metchnikoff in a hermaphrodite form, yet though the authors found many at La Hague, no trace of the condition was seen, so that this feature may be only occasional, as in the Serpulidae. They also incline to the opinion that in *Dodecaceria concharum* (A), in *Syllis vivipara*, and *S. incisa*, in *Cirratulus chrysoderma*, the forms are unisexual, and that, therefore, parthenogenesis occurs. As formerly stated, however, further observations are required before certainty is reached.

It will thus be seen that while the able authors have increased our knowledge considerably in regard to *Dodecaceria*, yet even in this form several important features remain for future investigators, such as the exact relationship of the three forms A, B, and C, and the development of each. These problems rest with southern observers, since *Dodecaceria* is rather rare in our colder northern waters.

The epigamous condition in annelids has, perhaps, its analogues in the medusoids of the Hydrozoa, the strobila of the tape-worm, the imago and specially the queens of certain insects, and the changes in the male cephalopod.

The relation of the changes in certain vertebrates is not so clear, but yet there is a thread of analogy in the alterations of the mandible of the male salmon, the coloration of the lump-sucker and other fishes at the breeding season, the changes in the air-sacs of certain amphibians, in the plumage of birds, in the passage of the testes outwards in certain mammals at puberty, and the development of fat, hair, and horns on certain regions.

The free discharge of the ova from the ovaries of the higher forms, their passage along the oviduct to the uterus, the development of the embryo in this organ, and lastly its extrusion externally, are only

further changes brought about by the high degreee of specialization in the mammals, and by the fact that the procreative power is continuous for a definite period after puberty. In the case of the annelid the changes in the individual are evanescent or terminal, whereas in the higher forms they are more or less permanent.

THE UNIVERSITY,
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Mehnert's Principles of Development.

By PROFESSOR J. ARTHUR THOMSON, M.A.

It is well known that the rapid development of embryology has been mainly along morphological lines; of the physiology of development we know extremely little. For a time the gap was filled by generalities—laws of growth, principles of development, polarities, and the like, in fact a plethora of vague speculation. Then came a stern reaction, a franker confession of ignorance, and a renewed enthusiasm for concrete research, as illustrated for instance in the recent boom of experimental embryology. Mehnert's work¹ is not experimental, but it abounds in measurements, and it is this that forms its attraction, for the beginning of measuring is often the beginning of science.

Two years ago Dr. Ernst Mehnert published an essay entitled "Kainogenesis," in which he gave the results of a comparative study of 384 extremities of various embryos from turtle to ostrich, and formulated certain general embryological conclusions. Far from accepting the prevalent vague idea of uniformity in development, he showed that each type or even species has its individuality as regards the order in which various parts appear and the rate at which they develop. He gave many illustrations proving that the time at which a structure appears in the individual development cannot be taken as indicative of the historical or phylogenetic age of that structure. In this regard he showed clearly that the familiar generalisation "ontogeny is a short recapitulation of phylogeny" must not be taken too literally. Not that our author doubts the famous biogenetic law; he only points out that in applying it care must be taken to appreciate the effects of varying rates of development in different creatures. It is this notion of time-displacements in development which has been elaborated in the second essay on the principle of organogenesis. In other words, the author seeks to show the importance of the developmental changes which may result from changes in the growth-rate of particular parts.

¹ "Biomechanik erschlossen aus dem Prinzip der Organogenese." By Dr. Ernst Mehnert. 8vo, pp. viii. + 177, with 21 figs. Jena: Gustav Fischer, 1898. Price 5 Marks.

Beginning with the vascular system, which he regards as essentially entoblastic in origin, and as originally derivable from a dorsal aorta or pair of arteries and a sub-intestinal vein, connected by metameric cross-vessels as in some Annelids, Mehnert maintains that the heart is a secondary differentiation, arising as the result of functional adaptation from a portion of the primary ventral vessel where the greatest resistance had to be overcome. But when we turn to the actual development of the heart, we find that in lamprey and dogfish, newt and frog, chick and pig, rabbit and man, the heart is differentiated *before* the associated main vessels. There is thus an obvious lack of congruence between the ontogenetic or individual, and the phylogenetic or racial, order of sequence,—a discrepancy which the author deals with in his proposed corollary to the biogenetic law. This corollary is, that as an organ rises in physiological importance and structural differentiation, it acquires a proportionate increase in its rate of development. In fact, as the author expresses it, the embryological key to phylogenetic age is not to be found in the order of appearance, but in the intensity of developmental energy. But what this developmental energy precisely is we are not told. A second illustration concerns the mammary glands. It is generally supposed that these have arisen from more primitive integumentary glands of less specialised type, such as the sebaceous or the sudorific glands. The debated question which of these is the more nearly related to the milk glands need not concern us now. What is striking is the fact that the primordia of the mammary glands appear in man, for instance, before there is any hint of sudorific or sebaceous glands. Again the individual development seems to reverse that of the race; again Mehnert gives the interpretation that the acceleration of the mammary glands is causally connected with their progressive physiological importance and structural specialization.

A third, and, as it seems to us, much less effective illustration is found in the pineal eye, which Mehnert regards as historically older than the paired eyes and possibly homologous with the eye of Tunicates. But in all vertebrates hitherto studied embryologically the paired eyes, if present, arise decidedly earlier than the pineal eye. The organ which has lost its functional dignity, so to speak, is handicapped in its rate of development.

Communications between the cavity of the "protovertebrae" and the cavity of the lateral plates are primitive in lower vertebrates like the lancelet and selachians, but they are not seen in the early stages of bird and mammal, yet Bonnet has described these communications in four segments in a *late* embryo of the sheep (15-17 days), and Dexter has made a similar observation in regard to the chick. This late occurrence of a structural detail which is doubtless on the retrograde path harmonises with Mehnert's view. Retrogression and retardation go hand in hand. The late occurrence of a neurenteric

canal in the higher vertebrates, and the late occurrence of cartilaginous connections between pieces of skeleton which arise isolated from one another, *e.g.* the connection which Wiedersheim demonstrated between the head of the femur and the pelvis in amphibia, are other cases in point.

After discussing the above instances in detail the author gives a tabular summary, the general result of which is, that phylogenetically progressive organs exhibit a general acceleration in their rate of development, while retrogressing organs tend to be more and more belated. A structure whose racial importance is waning cannot be *simply* suppressed; a structure whose racial importance is increasing cannot be *simply* exaggerated; there is no question of *per se* lopping off or tacking on; the embryological facts point to "an alteration of the entire course of development from the first appearance of the primordium (rudiment, *Anlage*) to the cessation of the process." This conception may perhaps be harmonised with Weismann's theory of a germinal struggle between the waxing and the waning determinants (or let us say structural units),—an unseen struggle within the germ-cell whereby an intra-selection abets the ordinary process of natural selection. The determinants which are in force in the germ, which secure success in nutrition and otherwise, will have a free course and an accelerated development. Having illustrated his central thesis,—that the rapidity of the growth of an organ is proportional to its degree of development, Mehnert proceeds to further analysis.

He first defines abbreviation as a premature cessation of development, illustrated for instance by numerous skeletal parts which do not complete their natural histological differentiation,—a cartilaginous metastyloid in a man fifty years of age, a cartilaginous epipubis in an ostrich twenty-five years old, or the more or less persistently cartilaginous sternum of certain cetaceans. From this "abbreviation" he distinguishes "retardation" or the slowing of the developmental process, as in the case of a wisdom tooth. Abbreviation is the insertion of a full stop at an early stage; retardation is slow growth long drawn out. But the two modes of retrogression may be combined.

Similarly, in regard to progressive structures, the author defines acceleration or the quickening of developmental processes, which he illustrates chiefly by comparing the different rates of growth of various skeletal parts during foetal life; and prolongation or the lengthening of progressive development, which he illustrates by the earlier and earlier appearance of certain primordia (*e.g.* of metacarpals and metatarsals), and by the extension of the growing period without loss in rate. But, again, the two modes of progression may act in concert.

In the turtle the long bones, such as humerus, femur, radius, and ulna, arise from primordia which differ but slightly from the average size of a carpal or phalanx rudiment. But although they start very

much alike, they do not grow at the same rate, and Mehnert's conclusion, which he seeks to establish by statistics, is that the rapidity of growth is proportional to the degree of development finally attained. The long femur grows most quickly, the short first phalanx of the thumb is slowest of all. The rapidity of the ontogenetic development (growth-process) of an organ is proportional to the height of differentiation which is eventually reached. And the rapidity is believed to be on the increase from generation to generation in the case of all structures which are still evolving.

This acceleration is said to be due to a cumulative inheritance of developmental energy. But we cannot rest here. It must surely admit of further analysis in terms of the conditions favouring cell division, the production of nuclein substances, and so forth.

Here then we have the author's thesis which claims rank as an induction, and it becomes of interest to hear what he has to say on the general problems of embryology. Even if we do not accept his conclusions, it is instructive to have the vexed questions re-discussed from a fresh standpoint. The endless references and the ten pages of bibliography show that the author has not been partial in his survey.

Like His, who first pointed out thirty years ago (1868) that growth proceeded at different rates in different parts of the embryo, and that the rate of growth increases with the physiological dignity of the structure, Mehnert believes that the conception of organ-forming germinal areas ("organbildende Keimesbezirke") is inevitable. He supports this by reference to the numerous independent individual variations in rate exhibited in the development of organs, which suggest that each part pursues its own path, now hastening and again lagging, and also by reference to Born's wonderful experiments on grafting tadpoles, where organs separated from their natural neighbourhood went on developing in a manner certainly suggestive of "self-differentiation." At the same time, Mehnert does not go to the extreme of denying that the development of an organ is influenced by its environment in the widest sense, *e.g.* by the pressure of an adjacent organ or by gravity.

In a number of curves and tables, the author gives the results of his measurements of the rate of growth from the beginning of the rudiment of an organ onwards. These all relate to parts of the skeleton, and show (in man) a rapidly ascending curve on to birth, and then a rapid decrease followed in early childhood by a slow rise. It seems to us that the exposition of these measurements, on which the whole point of the book depends, is very inadequate, the curves are badly done and most tedious to decipher.

He ventures to distinguish the first apex of the curve on to birth as the climax of the preformed character ("Evolutionselevation"), and the second in early childhood as the expression of acquired character ("epigenetische Elevation"), or the result of "functional hypertrophy"

induced by new relations to the external conditions of life. In other words, he regards the growth of an organ as the result of two factors. One of these consists of the inherited qualities,—the constitutional energies. The other (epigenetic) factor is in a word environmental.

The primary, constitutional, or inherited factors (Evolutionsdetermination) are fixed when the germ-cell is separated from the parent which bears it, or when fertilisation has occurred. The secondary, functional, or acquired factors (Entwickelungsdetermination) are found in the environmental conditions and in the internal relations of parts. Many have made this theoretical distinction before, the difficulty is to apply it.

It is easy to show that the course of development may be modified by external circumstances and by the immediate organic environment, and the author recalls many more or less familiar instances of determination by nutrition, by temperature, by actual functioning, by association with other parts, and by the environment in the broadest sense. But it seems to us that the conception of environmental relation requires more careful analysis than the author gives it; thus we have to distinguish (a) the relation of normal functional dependence, (b) the relation which results in a "modification" in the strict sense, *i.e.* when the limit of organic elasticity is transcended, and (c) the relation in which the environment supplies a variation-stimulus or inhibits a variation-tendency.

In regard to heredity, it seems to Mehnert that if a correlation be admitted between the rate of embryonic development and the functional importance of an organ, we are forced to admit the inheritance of acquired characters, to doubt which seems to him almost a reproach to the intelligence of a physician or observant naturalist! He insists on the parallelism between the racial evolution of an organ and its growth in the development of the individual, and seems to suggest that the former explains the latter.

But the peculiarity, the idiosyncrasy, of Mehnert's view is, that there is a transmission of specific energies from the parent to the germ-plasm which is the foundation of the offspring. The body of the parent is to the germ-cell as a mother-magnet to a daughter-magnet. There is in inheritance, he conceives, a constant element, the material germ-plasm; but there is also a variable factor, namely, this mysterious energy on the intensity of which the rate of development depends. In this hypothesis he does not mean to postulate an imponderable vital force; he heads his work with Ostwald's axiom that everything is to be interpreted in terms of energy.

If each step in racial evolution means not a mere lopping off or tacking on, but an alteration in the developmental rhythm of the organism, which seems a most reasonable conception, then the talk one sometimes overhears about uniformity of development had better be silenced, and already many only whisper the old error. Mehnert shows

his learning and experience to good account when he argues that in each species there is an individuality—eine Specificität—in development. And since there is variability each development is literally a “Kainogenesis.” This is one of the strongest sections in the book. Mehnert goes on to point out that an acquired character such as the strength of an athlete’s biceps has to be sustained by a continual repetition of the original stimuli which produced it, whereas congenital characters are at least represented, though not fully developed, even when they do not receive their appropriate functional stimulus. Persistence and length of life depend primarily on the constitution, there is only indirect gain in the acquired. It may save the life of the individual in struggle; it may, according to the modern doctrine of indirect selection or “organic selection,” save the race until a constitutional variation in the same direction is evolved. But to this consideration Mehnert adds his particular theory of cumulative energy. The life of a species runs on a principle of compound interest; there is a cumulative augmentation of the mysterious specific developmental energy.

The author makes a brave attempt to keep faith with the recapitulation doctrine, and with himself. He admits the individuality of development; he admits that the order of development in ontogeny is often the reverse of the order of evolution in phylogeny; he admits that we have to look for a recapitulation of stages in organogenesis rather than of stages of entire organisms, as Dr. Beard has also maintained; but he clings fondly to the old conclusion, provided it be corrected by the notion of a variable rate of growth. There is a suggestion here of the old shoe cobbled so often that there is nothing of the original left.

In the section on the degeneration or involution of organs, Mehnert points out that this is, so to speak, normal. The organism is an integrate of parts which have different rates of development. It is like the march of a great procession; some members are continually falling behind, others are always shooting on ahead. Involution and evolution go hand in hand. The ovum develops, the polar bodies degenerate; the blastoderm develops, the merocytes degenerate; the head grows and the tail dwindles; the higher nerve-centres of the Mammalian brain increase and the occipital region diminishes; the metanephros comes and the pronephros goes; the backbone strengthens and the notochord disappears; and so on throughout, a continual necrobiosis.

Mehnert’s essay might be in part described as a recognition of the time-element in development. The material of evolution is slow to change in kind—it is the germ-plasm—but its rate, and all matter has its rate, is more readily altered. We may not transmute the metals, but we can turn gas into fluid or solid at will, *i.e.* we can change the rate of molecular movement.

Thus our author ends fitly by expounding the effect of altering the

date of sexual maturity. Some ctenophore larvae are mature almost immediately after they leave the egg, but this is not true of the eagle. And though there are disadvantages, there are also some advantages on the side of the eagles. There is opportunity for the body to influence the germ-plasm, which nobody can deny. But having said so much we need not follow the author into his discussion of premature sexuality or neotaenia on the one hand, or of the advantages of late marriages on the other.

It must be confessed that the book we have been dealing with is hard to read and harder to expound, and it is quite possible that we have in various instances failed to catch the author's meaning. It is not easy to estimate how much it really amounts to—this "principle of organogenesis." But as our position in regard to the physiology of development may be compared to that of travellers hesitating in thick mist by the edge of a bog where path and pitfall are alike hidden, it would seem that he must be either a very wise or a very foolish person who takes it upon himself to dismiss lightly the suggestions of a measurer.

THE UNIVERSITY,
ABERDEEN.

A Note on Telegony, Xenia and "Hybrid Oology."

By G. P. BULMAN.

A GOOD sub-title for this paper would be "not proven"; as its object is to point out that though we have few grounds for any belief in the above phenomena, we have still fewer (apart from our personal wishes regarding our view of the causes of heredity!) for disbelief.

Telegony.

The phenomenon for which this word was suggested¹ is, as telegony, completely hypothetical at the present moment, and by a large number of scientific men is regarded simply as a manifestation of reversion. However, some consider that although in the great majority of cases the effect is probably due to reversion, yet there are a few cases (perhaps even less than one or two per cent as mentioned by Romanes²) in which an effect is produced which is telegonic. The fact that all those cases which are known, can be as easily explained by the one as by the other, makes scientific men feel rather shy of introducing a new cause. A good catalogue of such cases will be found in *Natural Science*, Dec. 1893, pp. 436-440, by Mr. F. Finn.

The first duty, therefore, of a student of this problem of heredity is to prove its existence, and I think the best way to do this is to reverse the usual experiments, and see if the progeny of a less highly specialised pair do not sometimes display traces of the previous union of the mother with a more highly specialised male; these effects could not be due to reversion.

My friend, Mr. Alex. Meek, and I are at present engaged in conducting experiments of this nature; but telegony is probably of such great rarity that it would be necessary for a very large number of verdicts of "not proven" to be given before any conclusion as to its non-existence could be arrived at. Perhaps the best experiment in this way is that of the rabbits suggested in our letter in *Natural Science*, Feb. 1899, p. 166.

¹ A. Weismann, "The Germ-Plasm," p. 383.

² G. J. Romanes, "An Examination of Weismannism," p. 199.

Should we consider that there is sufficient reason for supposing that telegony does sometimes occur, and is an occasional factor in heredity, we must then turn our attention to its cause, as it might prove of the greatest importance to any theory explanatory of this subject.

I think the explanation of the phenomenon given by Romanes¹ is the most satisfactory, for that given by the supporters of Pangenesis, and other like theories, postulates such an extraordinary activity and plasticity on the part of the spermatozoa and their contained gemmules. After reaching the ovaries too late for the fertilisation of the mature ovum they must be supposed to penetrate the walls of the generative organs and fuse with the somatic cells. Then these cells must cast off gemmules which by some means or other must reach and form part of the succeeding and yet immature ova.

The provisional explanation suggested by Weismann,—that the spermatozoa might penetrate the succeeding ova while yet immature, has two objections to it,—first, the improbability of the efficiency of the spermatozoon to penetrate the follicular coverings of an immature ovum; and secondly, the objection mentioned by Weismann himself, that “a supplementary fertilisation of an egg-cell in this manner must be considered possible. . . . But this has never been known to occur.”² The two explanations mentioned by Darwin³ may be passed over with the barest mention, the one of the intercommunicating blood vessels between the embryo and mother, because it does not hold good in the case of birds, and from Mr. W. Heape’s splendid experiments⁴ does not affect mammals; and that of imagination because “there are very slight grounds for any such belief.”⁵

As far as I know, the suggestion of Romanes has never been discussed since. It appears the simplest theory, and is one which, instead of showing telegony in the light of an objection to the Weismannian (or, in fact, any other) theory, is in perfect harmony with it.

Xenia.

This, the direct action of the male element on the mother-plant, is an extremely hypothetical theory, the only facts on which it is based being those mentioned by Darwin.⁶ De Vries⁷ and Focke⁸ have both expressed their doubts as to its occurrence, and until fresh experi-

¹ Viz. “that the life of ‘ids’ is not commensurate with that of their containing spermatozoa. . . . And . . . when subsequent ova mature . . . these dormant ids adhere to their porous walls, through which they may pass.”—*Op. cit.* p. 198.

² A. Weismann, “The Germ-Plasm,” p. 386.

³ C. Darwin, “Variation under Domestication,” vol. i. p. 437.

⁴ See *Nature*, December 30, 1897, in which is a report of Mr. Heape’s paper (published by the Royal Society) on the “Transplantation and growth of mammalian ova in a uterine foster-mother.” ⁵ C. Darwin, “Variation under Domestication,” vol. i. p. 437.

⁶ *Op. cit.* p. 427 *et seq.*

⁷ H. de Vries, “Intracellulare Pangenesis,” p. 206.

⁸ Focke, “Die Pflanzen-Mischlinge,” p. 500 *et seq.*

ments, which are urgently required, establish it beyond doubt, I think Weismann is fully justified in disregarding it.

"Hybrid Oology."

By this term (a very clumsy one, I confess—but *faute de mieux!*) I wish to denote that extraordinary phenomenon, which has been so often reported in connection with the eggs laid by a bird when fertilised by the cock of a different species. I refer to the supposition that at the time of fertilisation, not only is the ovum fertilised, but that part of the oviduct which secretes the shell is affected in such a manner, that the ovum on passing through is provided with a shell which partakes of the tints of the eggs laid by the cock's own species—and not only the tint but also the microscopic structure.¹ Instances of this kind are mentioned by Dr. Hans Gadow in Bronn's *Thierreich*, vol. Aves, p. 874, and by Natusius (*Journal f. Ornithologie*, 1874, p. 1), and a few have come to my own knowledge. A friend has informed me of a case in which he kept some fowls of the Orpington variety separate for a time, when they laid eggs of a buff (the ordinary) tint. He then allowed them to run loose in a large yard, in which were fowls of all sorts; but after a few months he again confined them in a separate pen. But for several weeks after the eggs laid by them were pure white. The Orpington breed having been so lately developed, I should have thought that they were simply reverting to ancestors of a white-egg-laying variety, had I not heard at the same time of two similar cases regarding black Spanish, a comparatively old breed. Mr. Meek tells me that in the magnificent collection of Mr. W. Mark Pybus, Newcastle-on-Tyne, he saw a clutch of eggs which had been laid by a black Spanish hen when fertilised by the black cock. While the eggs showed both in form and texture the well-known properties of those laid by the hen's species, in colouring they were almost indistinguishable from the cock's.

In the case of "hybrid oology," as in that of *xenia*, experiments have not been conducted to any great extent, and in all probability the supposed effects have arisen from some other cause, such as a previous cross.

I do not think we ought to rest until these three hypotheses are either proved to be justifiable, or, after an overwhelming number of unsuccessful experiments, relegated to the land of myths.

¹ A. Newton, "A Dictionary of Birds," Part I. p. 190.

FRESH FACTS.

PARTIAL AND TOTAL CONJUGATION. HANS WALLENGREN. "Ueber die totale Konjugation bei Vorticellina," *Biol. Centralbl.* xix. 1899, pp. 153-161, 3 figs. In *Epistylis simulans* and other vorticellids the process of "total conjugation" is not strictly total; the nuclei and most of the endoplasmic material of the microgonidium pass into the macrogonidium, but a shrivelled residue is left,—not quite dead, but fatally injured. So that the difference between total and partial conjugation is one of degree.

THE CROP OF BIRDS. GUST. SWENANDER. "Beiträge zur Kenntnis des Kropfes der Vögel," *Zool. Anzeig.* xxii. 1899, pp. 140-142, 4 figs. In this preliminary communication the author distinguishes four types of crop,—of Pigeons, of Raptore, of Rasores, and of Fringillidae and some aquatic birds.

CHAMBERED STOMACH IN A MONKEY. A. PILLIET AND R. BOULART. "Note sur l'estomac composé du Semnopithèque," *Comptes Rendus Soc. Biol.*, Paris, v. 1898, pp. 216, 217. The authors have elaborated Owen's account of the complex stomach of *Semnopithecus nomaeus*, which is so strongly suggestive of that of ruminants. A large cardiac portion, like a paunch, with numerous internal papillae, leads into a median portion with numerous side reservoirs, and beyond this there is a ridged cylindrical pyloric portion with two fibrous bands. The first portion is a storage area, the second portion is a true stomach, the third portion is divided by a groove from the oesophagus into two areas, of which that above the groove is oesophageal in character, while that beneath resembles the second portion. It is an interesting case of convergence.

COMPARATIVE EMBRYOLOGY OF THYMUS. F. MAURER. "Die Schilddrüse, Thymus und andere Schlundspaltenderivate bei der Eidechse," *Morph. Jahrb.* xxvii. 1899, pp. 119-172, 3 pls. 4 figs. In connection with gill-clefts, two sets of organs must be distinguished:—(a) Those which appeared in forms in which there was an open and functional gill-cleft system (thyroid, thymus, and post-branchial bodies), and (b) those which appeared only after the obliteration of branchial respiration (epithelial corpuscles and carotid gland). The organs of the first set develop in the lizard in a manner essentially the same as in *Anamnia*; the detailed differences are shown in comparative figures.

PULMONARY GANGLIA. A. E. METTAM. "On the presence of ganglia upon the pulmonary nerves" (a preliminary note), *Proc. Scottish Micr. Soc.* ii. 1898, pp. 195-203. The author calls attention to the relative abundance of ganglion cells in connection with the pulmonary nerves in the lungs of certain domesticated animals, e.g. sheep, during foetal life; and suggests that they may act as local respiratory centres until the reflexes are fully established.

TEMPERATURE AND REGENERATION. FLORENCE PEEBLES. "The effect of temperature on the regeneration of *Hydra*," *Zool. Bulletin*, ii. pp. 1899, 125-128. The author shows that the rate of regeneration in *Hydra grisea* and *H. viridis* varies with the temperature, the optimum being between 30° and 38° C.

POISONS OF PARASITES. G. H. F. NUTTALL. "The poisons given off by parasitic worms in man and animals," *Amer. Nat.* xxxiii. 1899, pp. 247-249. In a short article in the March number of our American analogue, Mr. Nuttall sums up the evidence advanced by Peiper and others to show that a number of parasitic worms, both nematodes and cestodes, give off poisons within the body of their hosts. These poisons may account for some of the peculiar symptoms induced by the presence of the parasites.

SUBMARINE PHOTOGRAPHY. L. BOUTAN. "L'instantané dans la photographie sous-marine," *Arch. Zool. Expér.* vi. 1898, pp. 299-330, 4 pls, 8 figs. The plates accompanying this paper show that the author has attained some measure of success in submarine photography. At a depth of three metres good instantaneous photographs may be obtained by utilising sunlight only and without getting into the water. It is probable that photographs may be effectively taken at much greater depths by utilising a powerful artificial light.

ROCK STRUCTURES. CATHERINE A. RAISIN. "On certain structures formed in the drying of a fluid with particles in suspension," *Proc. Roy. Soc. Lond.* lxiii. 1899, pp. 217-227, 2 pls. The powder of various rocks, when mounted in water for examination under the microscope, exhibits interesting forms when dried. The paper considers the origin and method of experiments, classification of forms produced, conditions and causes of formation, possible applications in nature, and results affected by crystallisation. The results may throw light on the origin of certain minor structures in rocks.

AT the March 21 meeting of the Zoological Society of London, Mr. F. E. Blaauw gave an account of the breeding of the Weka Rail (*Ocydromus australis*) and Snow-Goose (*Chen hyperboreus*) at Gooilust, N. Holland. The Rails could not be induced to complete the periods of incubation, always eating the eggs after sitting for a few days. One young was eventually hatched by placing an egg under a bantam-hen. The Snow-Goose (a female) paired with a male Cassin's Snow-Goose (*C. caerulescens*), and laid and hatched three eggs. The young birds, it is said, were apparently assuming the plumage of the male parent.

SOME NEW BOOKS.

"TO COUNT THE SEAS ABUNDANT PROGENY."

The Resources of the Sea as shown in the Scientific Experiments to test the Effects of Trawling and of the Closure of certain Areas off the Scottish Shores. By W. C. M'INTOSH, M.D., LL.D., F.R.S., &c. 8vo, pp. xvi. + 248, with illustrations and 32 tables. London: C. J. Clay and Sons (Cambridge University Press), 1899. Price 15s.

"There are as good fish in the sea as ever came out of it" is apparently Professor M'Intosh's matured opinion, and he would probably add—"and as many." He has had great opportunities, given to few, and from his very extended connection with fisheries' investigation he, if any one, is entitled to hold opinions of his own on the matter. So, as what we want on all fishery questions is light—more light, and free discussion, and especially *facts*, we welcome this book even although (not *because*) it may be interpreted by some as an attack upon the methods and conclusions of the Fishery Board for Scotland, with which Professor M'Intosh was at one time connected. We hasten at once to remove any possible false impression that our last statement may give rise to, by saying that we do not for a moment mean to indicate that the author shows any undue hostility to the Board. On the contrary, he seems to us to be at least animated by a fair and judicial intention in his treatment of the Board's statistics and reports. He is, however, severe in his occasional remarks upon the inefficiency of the Board's steamer, the *Garland*, and the general feebleness of her performances compared with the commercial trawlers; and his conclusions as to the state of the fish population round our coast, and as to the effects of trawling and of closure of areas, are diametrically opposed to those given in the Board's recent blue-books.

Professor M'Intosh's assumption of the judicial aspect is so marked in places that one is reminded of the gods sitting up aloft distributing merited censure and approbation with an even hand upon the mere mortals below who have had something to do with fishery matters—upon scientists at biological stations from Plymouth to Japan—upon chairmen of Boards, county gentlemen and sheriffs—the work of two of the English Sea-Fishery Committees even is mentioned with approval. All will concur, however, in the well-deserved tribute of respect which Dr. M'Intosh pays to the memory of Lord Dalhousie, "the popular statesman who was at the head of the Royal Commission (1883-85)"; and it would be well for those engaged in fisheries work always to bear in mind Lord Dalhousie's wise caution, "Remember others will follow, criticise, and check every step taken." We believe that those responsible for the scientific work of the Fishery Board for Scotland will, looking at the matter in this spirit, welcome Professor M'Intosh's criticisms of their methods and conclusions. But we do not for a moment suppose that they will accept his views, or leave his statements unchallenged. The Board, or their able scientific secretary, Dr. T. W. Fulton, will probably have a good deal to say in favour of their own reports,

and be able to give some solid grounds for the faith that is in them—a faith in the (ultimate) beneficial effect of closure against trawling, which has led them to extend their experiment from the Firth of Forth and St. Andrews Bay to the Clyde sea area, and finally to the vast extent of the Moray Firth.

And it is not difficult to see what an effective reply to the present book might consist in. Professor M'Intosh alludes in his preface to the 108 tables compiled from the Board's trawling statistics, and he gives us some thirty of these as supporting his case; but these, and the statements as to the different fish, strike the ordinary scientific reader as being meagre—the numbers dealt with are comparatively small, the occasions are few, and the areas traversed are not extensive. Moreover, Professor M'Intosh makes so much of the unsuitability of the *Garland* for the work, the smallness of her trawl, and the uncertainty of such results (p. 114, etc.), that one rather wonders that he was willing to trust any superstructure of argument and conclusion upon such slender and broken reeds. The deceptive nature of insufficient statistics is proverbial. We do not believe that the *Garland's* statistics are sufficient, as yet, to prove anything—except perhaps what Professor M'Intosh so frequently points out, the uncertainty of all such operations. Our critic shows that the results in the Board's first quinquennial period cannot fairly be compared with those in the second, since they were obtained under different conditions. We doubt whether there is a sufficiently extensive body of figures in any period to compare with any other with the view of arriving at such conclusions as those of the Board on the one hand or those of its critic on the other. It is probably premature to expect any important conclusions yet. It may be thought that ten to fifteen years is a sufficiently lengthy period of observation to justify a belief that results unvitiated by "accidental" and seasonal variations might have been attained. And that would have been the case if we had had before us all the results of the hauls of all the commercial trawlers working round our coasts during that period. [Why do not the Board of Trade in England and the Fishery Board in Scotland devise a mechanism for obtaining these most important returns?] But what can we expect from the occasional isolated scrapes (for they are little more than that) of a steam-yacht with a small trawl? There is one thing—amongst many—that Professor M'Intosh has made clear in this book, and that is, if the Fishery Board continue the experimental closure of sea areas for some years scientific men will expect them to do their best to settle these disputed questions by adopting a more vigorous and effective policy, so as to collect a body of statistics which will be sufficient and unimpeachable.

It is to be regretted that Prof. M'Intosh has rearranged the statistics according to his own ideas in a method which will probably not be accepted by the Board; and we fear that in some cases errors have crept in during copying and rearrangement which will make it necessary to have the figures carefully examined and verified before conclusions drawn from them can be trusted. We would ask Prof. M'Intosh whether the table on p. 196 does not contain an error of about 20,000 cwt. of cod in one year's work of the liners of the Moray Firth. We believe there are other errors in the same table. We have not had time to compare all the others with the original statistics, but it is evident that the tables must be received and used with caution.

The "Introduction" to the book gives a general statement of facts which, Prof. M'Intosh believes, "point to the conclusion that, with some exceptions, the fauna of the open sea, from its nature and environment, would appear to a large extent to be independent of man's influence." Well, that somewhat guarded statement may be difficult to contradict, and yet it gives an impression which we believe to be incorrect. So much depends upon what the "some exceptions" are, and upon what is meant by "open sea," "would appear," and "to a large extent." If the open sea means, for example, the North Atlantic, then we agree; but our fisheries are not there, and no one proposes to interfere with "Nature" in that wide expanse.

In the second chapter such important questions as the influence of trawlers and liners respectively upon the sea-bottom and the food supplies of fishes is discussed, and the results of the scientific work and the recommendations of the Royal Commission are fully considered. It is useful to have all these points collected and focussed by one who is so thoroughly familiar with them; but why stop short at the Commission of 1884, and not go on to consider the work of the more recent Select Committee in 1893? After all that we come to the statistics of the Fishery Board, arranged under the headings St. Andrews Bay, Firth of Forth, Moray Firth, and Firth of Clyde. Throughout the author seems attempting to demonstrate that the statements as to over-fishing have been exaggerated, that no denuding or exhaustion of the fishing grounds is taking place, or need be feared; and yet every here and there we meet with passages that suggest that he is himself only half convinced, or that he might possibly find arguments against his own contention. Surely the following are admissions of what he elsewhere denies:—"While, therefore, the present statistics show no serious diminution, it may be truly said that the total is kept up only by the supplies from Iceland, Faroe, and the Great Fisher Bank" (p. 100). "All that need be said at present is that, so far as can be ascertained, it would not appear that the closure of the inshore waters has made any marked increase in the fishes of the offshore waters. . . . No change, however, could be expected if the scarcity were due to general over-fishing" (p. 101). "And while the fishes may not, taking a broad survey of them, be very much reduced, and the totals in the market even increase, yet each ship and boat probably secures much less than in former times" (p. 102). "Instead, however, of placing the onus of the scarcity on any method of fishing, such as trawling, it would be more reasonable to lay the blame on general over-fishing" (p. 228). Even Dr. M'Intosh's phrases in regard to the prosperity of the fisheries, and their vast powers of recuperation, do not suggest too much confidence in the belief which he advances. He uses such terms as "no grounds for despairing," "condition is not unsatisfactory," "does not give rise to dissatisfaction," which somehow do not carry conviction.

This (the main) part of the book, giving the results of the closure experiments, conveys to the careful reader the impression that the author has turned the Fishery Board statistics inside out, gutted them, squeezed them and sucked them dry—if anything, even statistics, will stand such mixed treatment—with the result that he proves nothing except the insufficiency of the original material.

We must point out, however, that in his discussion and rearrangement of these statistics Prof. M'Intosh seems to have mixed up two very different things—the results from the closed areas and from the stations which were not closed. In this way he imports into the comparison of the conditions before and after closure a series of facts which have no right there. It is scarcely fair to draw conclusions as to the results of the closure from statistics of grounds some of which have never been closed.

In any remarks that are made as to the insufficiency of the *Garland's* statistics, it must be remembered that many valuable observations of other kinds have been made by the vessel and the scientific staff on board; and we should have liked to have seen in this book a little more acknowledgment of the important work done year after year both for the fisheries and for science by Dr. Fulton and by Mr. Thomas Scott.

The final chapter, "Summary and Conclusions," is the most interesting to read, and with much of it every biologist will agree. We have alluded to some of the chief points in the preceding paragraphs. Here and there we meet with severely sarcastic passages directed against the "practical" gentleman and the "fisherman's friend." Who are they, and what have they done? Is science not practical, and is Prof. M'Intosh himself not the most practical of all those who have had to do with the regulation of fisheries? And, again, who has such

claims to be regarded as the "friend" of the fisherman (*of to-day*) as he who has such trust in the "Resources of the Sea" that he would remove all restrictions upon fishing? Was it not Prof. M'Intosh who suggested a few years ago to the Select Committee that the North Sea should be divided into four portions, one of which should be closed each year against fishing? What is the Moray Firth compared with a fourth of the North Sea?

The book is admirably got up. The printing and the illustrations (views of St. Andrews and of fishing life) are excellent, and we have noticed wonderfully few misprints or mistakes:—"Machig" bay (p. 211) we take to be Mauchrie; and we believe Davaar to be the more correct spelling of the island off Campbeltown; "the late Mr. Spencer Walpole," referred to several times in these terms, is, we are glad to say, still with us as Sir Spencer Walpole, K.C.B.

Scottish zoologists have long regarded Professor M'Intosh as their leader, and as a pioneer in the application of science to the fisheries. This fresh work from his ever active hand and head will be received with gratitude and admiration even by those who cannot entirely agree with all its conclusions. L.

ANOTHER BOOK ON BIRDS.

Birds: The Cambridge Natural History, vol. ix. By A. H. EVANS, M.A., Clare College, Cambridge. 8vo, pp. xvi. + 635, with 144 figs. London: Macmillan and Company, 1899. Price 17s. net.

To write a book on birds is, one would imagine, the easiest of tasks, to judge at least from the steady and constant stream that pours forth year by year from the various publishing houses of this country. Nevertheless, though many are published but few are chosen. The latest claimant to our attention is one of the "Cambridge Natural History" series, and is, in some respects, a useful book. In the preface Mr. Evans tells us that "he has essayed the difficult and apparently unattempted task of including within some six hundred pages a short description of the majority of the forms in many of the Families, and of the most typical or important of the innumerable species included in the large Passerine Order." This is one of many statements to which we shall have to refer, as showing a lack of appreciation of the work of contemporary writers. In the "Royal Natural History," published some three or four years ago, there appeared a volume on birds in every way equal to the present work, and, in many respects, better.

The general plan of this work resembles that of Flower and Lydekker's "Mammals: Living and Extinct." It is divided into seven chapters, the first being introductory, and the rest devoted to the general descriptive matter. The frame-work upon which it is built is a good one, the classification adopted being that of Dr. Gadow. For the facts with which it is crammed the author is largely indebted to the "Dictionary of Birds," and Dr. Gadow's second volume on the Classification of Birds in Bronn's *Thierreich*.

In the general scheme of the systematic portion of the book it was apparently intended to prefix to each group a brief survey of the salient features of the external characters; those eventually selected are such as the number of toes, form of the beak, the presence or absence of an aftershaft, and so forth, added to which there frequently occurs the somewhat inconsequent statement that "the syrinx is tracheo-bronchial, and the furcula U-shaped," or otherwise, as the case may be, two isolated anatomical facts which seem singularly inappropriate and out of place here; moreover, they are often in addition, as statements of facts, incorrect.

In passing in review the account of the different groups, we notice many errors and many omissions. In the penguins, for instance, the tongue is said to be rudimentary (? vestigial). A moment's reference to the plates in Watson's magnificent monograph, published in the "Challenger" Reports, would have

shown this to be quite the reverse of true; but, strangely enough, this work is not referred to in this book. Although we are told that the syrinx is tracheo-bronchial, no mention is made of the median vertical septum running up the trachea in some penguins and in some petrels; moreover, there are *no* feathers in the penguin's wing which can be distinguished as primaries, there *are* apteria on the body, and the feathers are *not* scale-like. The number of times this last statement has to be contradicted is positively irritating.

No mention is made of the fact that in the grebes and some storks there are twelve primary remiges; on the contrary, the order Ciconia is definitely stated to have eleven. The adults and young of the order are said to "possess uniform down," whatever this may mean.

The nestlings of tinamous are birds "which run from the shell." The nestling-down is described as "simple, as in Ratite birds"; and this in spite of a paper in the "Ibis" for 1895, pp. 1-21, 507-9, on the pterylography of the tinamou, drawing attention to the fact, amongst other things, that the nestling-down of the tinamou was the most complex of all hitherto described. This, like that of the Anseres and Galli, as has been pointed out by the same writer, is further remarkable in having a large aftershaft rivalling that of the main shaft. The nestling-down of *Rhea* again has an aftershaft, a fact pointed out by Dr. Gadow in the "Dictionary of Birds," and which, strangely enough, Mr. Evans has overlooked. The curious succession of the remiges of the nestling Galli and of *Opisthocomus* find no mention in this book. But, enough, as to sins of omission.

"An introductory chapter," we are told in the preface, "has been written to meet the claims of the present day, on the external and to a limited extent on the internal structure of birds." We must refuse to believe that "the claims of the present day" will be satisfied with the meagre and often incorrect information to be gathered from the pages of this work, on the external and internal structure of birds.

In this introductory chapter, and throughout the book, the word "maxilla" is used for the whole upper jaw, an abuse of this word which is absolutely indefensible. The section devoted to feathers is very inadequate, even for this book. No mention is made of semiplumae, or filoplumae, or any distinction drawn between nestling-down and down feathers proper. The pterylosis of the wing is not touched upon, nor is any reference made to quinto- or aquinto-cubitalism, or the exceedingly interesting work on "Overlap" by Goodchild.

In describing the skeleton we look in vain for any reference to the forms of the palate, or of the nostrils (holo- and schizorhinism), or to the supra-orbital grooves so characteristic of groups such as the penguins, petrels, divers, gulls, and plovers. To describe the index digit of the penguin as fusing with the pollex is like talking of "the tail that wagged the dog!"

Two pages are devoted to terminology. The value of these is hard to see. Some words, such as allantois, amnion, procenial (why not also ecto- and ento-enemial) appear to occur nowhere else in the book. The definitions of amnion, broncho-tracheal and tracheo-bronchial syrinx, are all more or less unintelligible. Eleutherodactyl and syndactyl are not mentioned, though other forms of the avian foot are.

Although Mr. Evans has drawn so largely upon the "Dictionary of Birds" for the facts embodied in this compilation, he has caught nothing of its style. The crisp and elegant English of that book is here conspicuous by its absence. We cull the following from his description of the *Rhea*:—"The hens secured by each of the cocks lay together in a mere depression in the soil with very little, if any, lining; the eggs numbering from twenty to thirty . . ." And again, in describing the habits of the Norfolk plover, he writes:—"The mournful whistling cry . . . is chiefly heard at twilight, when the bird feeds upon worms, insects, molluscs, or even reptiles, frogs, and mice." And again, on the same page:—"The forms with almost uniform breasts, and a black patch or line over the eye." Surely we have a right to expect something better than this of a

book coming from one of our great universities. Nevertheless, on this volume Mr. Evans has undoubtedly expended much time and labour, and the information he must have gained during its compilation will stand him in good stead should a second edition ever be called for, in which case, if he will thoroughly revise the whole and extend the introductory part, he will succeed in making a really useful work.

The majority of the illustrations are by Mr. Lodge, and some of these are very good.

W. P. PYCRAFT.

GEOGRAPHICAL DISTRIBUTION OF PLANTS.

Pflanzen-Geographie auf physiologischer Grundlage. By Dr. A. F. W. SCHIMPER, Professor in Bonn University. 8vo, pp. xviii. + 876, with 502 plates and figures and four maps. Jena: Gustav Fischer, 1898. Price 27 Marks.

This charming volume will, we doubt not, prove one of the most useful numbers of the excellent botanical series which Messrs. Fischer have been issuing during the past few years. It is an able exposition of that phase of the science of plant-life, the study of which, till recently neglected, was brought to the front by the publication of Kerner von Marilaun's "Pflanzenleben." In brief, it is an account of the relation between plants and their environment and an explanation of plant geography in terms of these relations. It also affords a striking example of the value of good illustrations towards the elucidation of scientific facts. Such is the profusion of the plates, most of which are reproduced from photographs, and so excellent their character, that a student ignorant of German may gain a very fair idea of plant-life under varying conditions of climate or association by merely looking at the pictures. The labour involved in procuring so fine a series of photographs depicting vegetation "in the rough" in all parts of the world must indeed have been great; but Professor Schimper cannot but feel well satisfied with the result. Those who have seen the book will understand how impossible it is to select individual cases for honourable mention, and those who have not seen the book should embrace the first opportunity of becoming acquainted with its contents. There are rumours of an English translation. Generally speaking, we do not commend translations from the German for our students, but so exceptional a work may well supply an exception.

The subject-matter falls into three sections. Part I. enumerates the operating factors—Water, Temperature, Light, Air, Soil, and the Animal World. Each forms the title of a chapter in which is studied the response of plants in form and function to the condition in question. Part II. is called "Formations and Associations." Under the former title are discussed the types of vegetation brought about by climatic and soil conditions; under the latter the mutual relationships involved by a climbing, epiphytic, parasitic or saprophytic habit. Part III., occupying more than two-thirds of the whole, treats of Zones and Regions, and describes the plant life of the tropics, the temperate and arctic zones, and alpine and aquatic conditions.

At the end of each chapter is a list of books and papers dealing with the subject under treatment, and at the close of the volume are four excellent double-page maps illustrating the annual rainfall over the world and its seasonal distribution, and the distribution of the most important botanical formations in the world generally and North America in particular.

A. B. R.

EVOLUTION OF FRUITS.

Sketch of the Evolution of our Native Fruits. By L. H. BAILEY. 8vo, pp. xvi. + 472, with 125 figures. New York: The Macmillan Co., 1898. Price 7s. 6d.

From Professor Bailey always something new! and moreover refreshing in its novelty, and put before us in so bright and interesting a manner that even the account of the origin of the numerous varieties and forms of cultivated fruits becomes a story fraught with interest and often with romance. With the history of the evolution of the fruits which are familiar to every citizen of the United States, the author has interwoven the life-story of the workers to whom is due the vastly improved condition of the fruit of the market as compared with its ancestor of the woods. And a great nation is much indebted to Professor Bailey for bringing into prominence, often at the expense of considerable work and trouble, the facts of the life of those who have rendered invaluable services in fields which are but little appreciated. His book is moreover a striking controversion of the argument that with so many good fruits and vegetables, the outcome of centuries of cultivation, it is waste of time for man to make new beginnings on the endemic products of a new continent. The story of the attempt to grow the Old World vine on New World soil is pathetic in its unbroken series of futile efforts, ruined prospects, and sometimes hearts broken by a succession of disappointments. But the story of the evolution of new kinds, in many ways superior to the European stocks, from the native American species, should be an inspiration to agriculturists working in a new country. While appealing more directly to our Transatlantic brothers, the book has a wide general interest, and in particular we would heartily recommend it to the botanist as a pleasant change from the more severe literature of his subject.

A. B. R.

ZOOLOGICAL RESULTS.

Zoological Results. Based on material from New Britain, New Guinea, Loyalty Islands, and elsewhere, collected during the Years 1895, 1896 and 1897, by ARTHUR WILLEY, D.Sc. Lond., Hon. M.A. Cantab. Part II. 4to, pp. 121-206, plates xii.-xxiii. Cambridge University Press, 1899. Price 12s. 6d.

The contributors to this part of Dr. Willey's "Results" are for the most part well-known authorities on the subjects on which they report. Of the eleven excellent plates illustrating the 74 pp. of text, we have besides lithographs, of which one is coloured, both photographs and photogravures, in each case probably as well as they could be done. This juxtaposition of the two last-named processes is of no small interest. The decision as to which method is preferable will of course depend upon the point of view, but the working zoologist can hardly fail to decide for the photographs, which will stand examination with a pocket-lens.

Confining ourselves to matters of general interest, we would call special attention to the first paper. It is by Prof. Hickson, and in it he shows us how to classify the Milleporae without the use of that indefinable word species. The various growth-forms are termed "facies." Instead of species "*complanata*" it is facies "*complanata*," and so on. This seems to assume some stability in the different forms, and that there are some laws of growth, both general and special, which when they can have free play result in definite recognisable shapes. If so, it is open to doubt whether the mere change of words is of sufficient importance to warrant its adoption. Apart from this criticism the paper itself suggests the question whether systematists generally might not

with advantage refuse to employ terms which they cannot clearly define. Although Prof. Hickson denies the existence of anything which corresponds to what he thinks to be the meaning of the word "species," only in *Millepora*, may we not go further and ask whether the haziness of the concept does not demand, in the interests of scientific thought, the general adoption of some more definable terminology?

As an illustration, on p. 175 Mr. Stanley Gardiner, who reports on the Stony Corals, is driven to express, and then immediately to suppress, a doubt as to whether *Cycloseris* and *Fungia* can be generically distinct. There is only one method of deciding such a point, viz. by extended comparisons; this will either reveal transition forms or else make it more and more improbable that any such exist. At present the systematic divisions into "genera" and "species" are, as the perplexed worker knows to his cost, too often little else than the result of guess-work. An unfortunate terminology stands in the way of precision. Having accepted the genealogical method in principle, is it not time that we ceased to limit it to the main stems and branches of the animal kingdom? Why not attempt to carry it to its logical conclusion and replace those nebular concepts "genera" and "species" by branching lines of differentiation? This, however complicated and difficult to work out, would, at least, admit of accurate treatment.

From this point of view it is gratifying to note that a new starfish is figured by Prof. Jeffrey Bell, and that he contents himself with calling attention to its leading features, and wisely refrains from endeavouring to give it a place in the system by guess-work. It must stand alone until fresh specimens help to link it on somewhere.

Mr. Beddard reports on the Earthworms and Mr. Shipley on the Sipunculids—and two new zoologists, Miss Isa Hiles and Mr. F. E. Bedford, appear on the field. The former describes the Gorgonacea and the latter the Holothurians. In welcoming them we cannot refrain from congratulating them on beginning their original work with systematics. The purely anatomical and morphological work of the laboratory course requires the starch taken out of it by actual experience of the extreme variability of organic life, and by learning that even the most stable of animal types is apparently quivering under the suppression, by the environment, of its power to change.

We congratulate Dr. Willey, and the band of able zoologists who are lending him their assistance, on the appearance of this solid instalment of the results of his travels.

H. M. B.

HISTORY OF BIOLOGY IN MINIATURE.

The Science of Life: An Outline of the History of Biology and its Recent Advances. By J. ARTHUR THOMSON, M.A. 8vo, pp. x. + 246. (The Victorian Era Series.) London: Blackie and Son, Limited, 1899. Price 2s. 6d.

No more welcome book could be placed in the hands of the student of the history of science or of thought than this little volume on the "Science of Life." It is a review of all the scientific labours which centre in and bear upon the great phenomena and the problem of life: a history of biology in the widest sense. As such it fills a space which was empty before in the history of the sciences, though many suggestive essays or addresses by Huxley, Michael Foster, Burdon Sanderson in England, by du Bois Reymond, Claude Bernard and others abroad, have created a lively desire for a more comprehensive treatment of this fascinating subject. There are only two books with which we could compare the volume before us: the one is Sachs' "History of Botany," the other is Delage's great volume on the "Grands problèmes de la Biologie." Though we read the latter with interest and profit, we would recommend Mr. Thomson's small volume as a better guide through the tangled maze of biological reasoning.

In this country biology is a very modern science, and in popular opinion Darwinism or the doctrine of descent is the dominant conception which governs it. Mr. Thomson introduces us to the foreign and pre-Darwinian thinkers, Lamarck and Treviranus, who coined the term biology, and to those who formulated the idea of a comprehensive doctrine of life and of the economy in living nature : von Baer, Liebig and Boussingault, Johannes Müller, Claude Bernard, and many others. We are shown how the older natural history of Ray and Linnaeus became gradually unified and enlivened by the study of development, of the interdependence of natural beings, by the great generalisations of the cell theory, and finally by the theory of descent and evolution (Darwin and Spencer). We are shown the changes which the term "Vitalism" has undergone. It is not a paradox to say that, so long as the objects of nature were studied in their isolation, torn out of their natural environment and company, the study of living things was the most lifeless of all studies ; it has only recently become a living study. How this has been brought about, the volume before us tells clearly, concisely, and attractively.

Special studies cease to be dry and mechanical when we are enabled to see the place and importance which they have in the great array of researches into the nature and significance of life. We heartily recommend the book alike to historians, philosophers, and biological specialists. British and foreign contributions are treated with equal impartiality ; the orthography of foreign names—often faulty in similar books—seems very correct. We think we have noticed only one mistake, which, however, in the unfortunate absence of a complete index of names, we cannot at the moment refer to.

J. THEO. MERZ.

SUCCESSFUL POPULARISATION.

Wonders of the Bird World. By R. BOWDLER SHARPE, LL.D., F.L.S., &c. Assistant Keeper Sub-department Vertebrata, British Museum. With Illustrations by A. T. ELWES. 8vo, pp. xvi. + 397, 3 plates and 233 figs. London : Wells Gardner, Darton and Co., 1899. Price 6s. net.

Under this title Dr. Bowdler Sharpe gives us an acceptable and attractively written volume—an amplification of his popular lectures on the "Curiosities of Bird-life." A glance at the table of contents makes it manifest that among no class of animals do we find such multifarious "wonders" as among birds. Here we find chapters devoted to wonderful extinct and existing forms, to decoration, to playing grounds and gardens, to wonderful nests, to courtship and dancing, to mimicry and protective resemblance, to parasitic birds, to migration, and to geographical distribution.

Though the book is popular in its aims, yet it will prove useful to ornithologists as a work of reference, for Dr. Sharpe has gleaned his material from the vast and widely scattered fields of zoological and other literature.

In his treatment of the migration of birds, the author has scarcely done either himself or his subject justice. We are told, and it is quite true, that we have very much to learn concerning the wonders of migration. But it is equally true that considerable advance has been made in our knowledge during recent years, and that some highly important and interesting facts have been well established. To these no allusion is made. Something too might have been said regarding the marvellous journeys performed by migrants, almost equalling, as they do in some cases, an annual flight round the world. Other phases of this wonder of wonders of the bird-world might have been mentioned with advantage. This is, however, admittedly the imperfect chapter among many that are excellent. The book is nicely got up, well illustrated, and most reasonable in price.

W. E. C.

A FIRST INSTALMENT.

Applied Geology. By J. V. ELSDEN, B.Sc. Part I. 8vo, pp. 96, with 57 figs. London : "The Quarry" Publishing Co. Ltd., 1898. Price 5s.

For a very large proportion of the raw materials used in our industrial arts we are indebted, directly or indirectly, to mother earth ; and hence a good work on practical geology, teaching us how to develop our mineral resources, ought to appeal to a wide circle. Mr. Elsden, in this rather slender volume, concerns himself with only a small corner of the subject ; indeed, it may be doubted whether the issue of the work, in its present form, is not somewhat premature. The matter has already appeared serially in the columns of a very useful technical journal called *The Quarry*, where a continuation is now in course of publication, month after month. It would therefore, in our opinion, have been wiser to wait until the whole subject was completed, instead of reprinting the work in a fragmentary form.

So far, however, as the author goes in this first part, he may be followed by the student with much profit. A large proportion of the volume is devoted to instruction in geological surveying, and deals with problems connected with the dip, the strike, and the outcrop of strata. These subjects are necessarily of a mathematical character, but Mr. Elsden handles them in a simple and satisfactory fashion. The last chapter, forming 20 pages of the book, is descriptive of the principal stratified ore-deposits. Here the writer deals, first, with such detrital deposits as those containing gold, platinum, and tin-stone ; then with ores precipitated from a state of chemical solution, such as bog iron-ore, clay ironstone, manganese-ores, and bauxite ; and, finally, he describes those deposits in which the ores are disseminated through sedimentary rocks. It is in the last section that attention is directed to such important deposits as the copper-shales of the Permian beds, the metalliferous sandstones of the Trias, and above all else the famous "banket," or auriferous conglomerate of the Transvaal.

The work is illustrated by a number of figures which, though clear, are in many cases rather coarsely executed, and are needlessly large for so small a book.

A FIFTEENTH EDITION.

Kirkes' Handbook of Physiology. By W. D. HALLIBURTON, M.D. Fifteenth Edition. Pp. xxiv. + 872. London : John Murray, 1899. Price 14s.

When a class text-book has reached its fifteenth edition and is so largely used by the students of the present day as this compact volume is, then it must fulfil the requirements of its patrons. Probably the reason for this is that it takes up the whole subject of physiology, including also histology, so that a student obtains in a single volume practically all that he requires for examination purposes. The author has spared no pains in keeping it abreast of the most recent research in physiology. Every chapter shows not only signs of revision, but important matter has been added, such as Langley's recent work on the union of vagus and cervical sympathetic, Hammarsten's researches on blood coagulation, and those of Kossel on the constitution of the proteids. There are also numerous other additions, such as Sherrington's work on the reciprocal action of antagonistic muscles, and Haldane's researches on methaemoglobin. Here and there slight errors have escaped correction, as, for example, the definition of the posterior chamber of the eye given on page 738.

It is, however, a reliable general text-book. There can be no doubt that any student, who reads it carefully, will attain a good grasp of modern physiology.

T. H. MILROY.

AN AMERICAN INTRODUCTION TO AGRICULTURE.

The Principles of Agriculture. Edited by L. H. BAILEY. 8vo, pp. xvi. + 300, with 92 figures. New York: The Macmillan Co. London: Macmillan and Co., 1898. Price 4s. 6d.

This is a book of unequal merit, better in the conception than the execution. Designed for Americans, it is written in the American language, and its "roiley streams" and "fitted fields" will hardly be recognised by English readers. Work done outside America is ignored, nor does any English book find a place in the bibliographical references. Opinions may differ as regards the wisdom of this, but there can be no difference of opinion in regard to matters of fact. There is manifestly a double error in the statement that haws are mixed with sand in autumn and sown in the following spring, the operation being known as "stratification." One wonders how the thousands of sheep annually fed on pasture or turnips, without access to water, manage to exist, if "no food contains so much water that it can be used by the animal to supply its needs both for water and solid matters"; and what have Scottish dairy farmers to say to the statement that "cattle should not be fed (*sic*) hay composed wholly of timothy and similar grasses"? The frequency of such errors makes the book unsuitable for students.

W. S.

The *American Geologist* for January 1899 is remarkable for its review of the life and work of Prof. E. D. Cope, written by Helen Dean King of Bryn Mawr, Pennsylvania. The bibliography, extending to 815 entries, will be of service to every naturalist. It is noteworthy that almost the whole of Cope's scientific contributions, from 1859 to his death in 1897, should have been devoted to the vertebrata. Few naturalists of his time, and probably none in the first half of this century, could show such a concentration of energy, combined with so large a literary output.

In the same number Mr. Manson publishes his "Laws of Climatic Evolution," in which he urges that an Ice Age occurs in the history of a cooling planet, at the period when the internal heat ceases to affect the surface-temperatures, but when the vapour from the warm oceans still shields the earth from solar heat. As this vapour is deposited in the form of snow upon the land-surfaces, which cool most rapidly, glacial conditions result, followed by a steady warming of the earth, as the atmosphere becomes free from clouds. In time, as the oceans become warmed by the sun, the new cloud-layers tend to check the general rise of temperature. The old arguments about the uniformity of tropical conditions in Mesozoic and Palaeozoic times are put forward as beyond dispute; and the numerous authorities quoted give the essay a more magisterial air than it might otherwise possess.

In the January number of the *Psychological Review* (vol. vi. No 1), besides an interesting address by Prof. Münsterberg on "Psychology and History," and an elaborate paper entitled "A study of the relations between certain organic processes and consciousness," dealing mainly with circulation and respiration, Mrs. Ladd Franklin contributes an admirable *résumé* of Prof. G. E. Müller's theory of the Light-sense. This theory has some genetic relationship to that of Hering, but is worked out on independent lines and with different postulates. For the antagonistic processes of assimilation and dissimilation Prof. Müller substitutes the conception of reversible chemical action. We recommend all those interested in fascinating and difficult problems of colour vision to peruse this summary of Prof. Müller's thesis.

The *American Journal of Psychology* for last October (vol. x. No 1) contains an elaborate and, it would seem, carefully conducted investigation on the applicability of Weber's Law to Smell (E. A. M'C. Gamble). The subject is too technical to render a brief description of methods and results possible. We must content ourselves, therefore, with directing the attention of those interested

in psycho-physical problems to Miss Gamble's paper, in which she claims to offer some evidence that Weber's law applies to smell and that the value of $\frac{\Delta r}{r}$ lies between $\frac{1}{4}$ and $\frac{1}{5}$.

In the April number of *The Naturalist* there is an interesting article by Dr. P. Q. Keegan on the physiological changes associated with the bursting of the buds in spring. The numerous buds which are distinguished by a pinky-red colour "contain apparently all along, and from the first moment of their existence, a certain quantity of tannic chromogen ready formed; all other leaflets contain merely the tannoid quercetin, or one of its allies, whose presence may possibly influence to some extent the tint of its infantile drapery." The deep brown of the opening leaves in the cherry, etc., is apparently due to tyrosine, a decomposition product of albumin.

In a paper on the making of the land in England, which appears in the *Journal of the Royal Agricultural Society*, Mr. Albert Pell returns to a subject which he has previously discussed. He describes the recovery of an area of 1350 acres of land and swamp which was in a state of nature as recently as 40 years ago, the enclosure award being dated December 19, 1861. The land was inter-commonable of seven parishes, and was indicated on the Cambridgeshire map by the not very euphonious name of Grunty Fen. The whole story of the making of this land is told in a manner at once circumstantial and dramatic. This and other instances of a similar character which Mr. Pell has placed on record help to demonstrate the fact that the farm lands of England, before the cultivator or husbandman could turn a furrow or stock an acre, had first to undergo the process of manufacture at a large outlay of enterprise, money, and labour.

A useful publication, now in its fifth edition, is the *Naturalists' Directory*, published by Mr. L. Upcott Gill, and sold for one shilling. It contains the names and addresses of several thousand naturalists, and has been carefully edited. We notice, however, some strange omissions and wrong classifications, which suggest that it would be well for the publisher or editor to send proof copies for revision to experts in different departments, and to secretaries in important centres. Thus, under the heading *Edinburgh*, there is no mention of the Scottish Natural History Society, which is certainly one of the most vigorous of the many societies in that fair city.

The heading "Books of the Year" should either be made much better or dropped altogether. We do not see what 'Prantl and Vines,' for instance, has particularly to do with 1898, nor why sundry reprints from societies' proceedings should bulk so largely as they do. But additions and corrections for the next edition are cordially invited by the editor before November 25, 1899.

In the April number of *Knowledge*, Mr. Charles A. Mitchell, well known for his work on the evolution of bird-song, describes some instances of "love-gifts"; in other words, cases where a bird offers food to a courted companion or a brooding mate. Apart from fowl and pigeon, he describes the offering of love-gifts in the spotted flycatcher, the chaffinch, the robin, and the willow-wren. In the same number there are interesting articles by Prof. Arthur Thomson of Oxford on the anthropological data furnished by the hair, and by Prof. Grenville A. J. Cole on the fauna of the lowest Cambrian.

In the *Scientific American* of April 1, Prof. C. F. Holder has a short article on "Insect Migrations," in which, though dealing especially with locusts, he records a migration of yellow butterflies (*Colias*) that was remarkable for its duration and the vast numbers that formed the swarm. For three or four days Mr. Holder observed a continual stream of butterflies fluttering on, in the same direction to the north-east, and by personal observation he found that the flight of millions extended over 16 square miles, while reports from other centres made it certain that the area of migration was very much greater.

OBITUARIES.

OTHNIEL CHARLES MARSH.

BORN OCTOBER 29, 1831 ; DIED MARCH 18, 1899.

THE death of Professor Marsh, of Yale, removes the last of the small band of pioneers in Vertebrate Palaeontology in North America. The Far West was becoming ready for scientific exploration at the time when he had completed an unusually extended college career, and his ample wealth enabled him to avail himself fully of his opportunities. He thus organised and led a series of expeditions which met with so much success in discovering the skeletons of extinct vertebrate animals, that the name of Marsh soon became a household word in connection with the recovery of wonderful lost creations. He died in the midst of work after only a week's illness, an attack of pneumonia proving fatal to his already enfeebled constitution.

Othniel Charles Marsh was born at Lockport, New York State, in 1831, and eventually entered Yale College, where he graduated in 1860. He remained for two more years engaged in geological and mineralogical studies, in the Sheffield Scientific School at Yale, and thence proceeded to Germany. He studied under Ehrenberg, Beyrich, Gegenbaur, Ferdinand Roemer, and others, in the universities of Berlin, Heidelberg, and Breslau. He returned to America in 1866, and became Professor of Palaeontology in Yale College, filling this honorary position, which was specially created for him, until the time of his lamented death.

Professor Marsh never lectured or gave systematic instruction in the college, but was able to devote the whole of his time, energy, and resources to the foundation of a Museum of Palaeontology and original researches connected therewith. He was a nephew of George Peabody, whom he induced to present to Yale a large sum of money for the foundation of the Peabody Museum of Natural History. One of the wings of this great institution was erected at once and became the scene of Professor Marsh's work ; the remainder has still to be built.

Until Marsh proceeded to the German universities, his chief interest centred in mineralogy, and his first paper, published in 1861, referred to the occurrence of gold in Nova Scotia. He wrote several other notes on minerals, and contributed to the fifth edition of Dana's "Mineralogy" in 1868. His studies in Germany, however, led him to direct special attention to palaeontology and comparative anatomy ; and he began the series of researches by which he is now best known. He first published a short description of two Labyrinthodont vertebrae from the Coal-Measures of Nova Scotia, assigning them to a new Ichthyosaurian Reptile (*Eosaurus acadianus*). He then contributed a series of notes, chiefly on invertebrate fossils, to the German Geological Society in 1864 and 1865. His first paper on fossil vertebrates from the West was a "Notice of a new and diminutive species of fossil Horse (*Equus parvulus*) from the Tertiary of Nebraska," published in the *American Journal of Science* in 1868.

After the latter date Professor Marsh himself began the remarkable series of explorations in the West to which we have referred ; and henceforth he announced a constant succession of remarkable discoveries of extinct vertebrata, making known not merely new genera and families, but also several entirely new orders. He first discovered the Cretaceous toothed birds (*Odontornithes*), of which he published several preliminary notices and eventually (in 1880) a great monograph for the United States Geological Survey. Another series of preliminary notices of a race of early Tertiary mammals, of elephantine proportions, with paired horns on the head, culminated in a similar memoir on the *Dinocerata* in 1884. A constant succession of preliminary notices in the *American Journal of Science* relating to other remarkable extinct vertebrates were intended to be followed by further monographs published by the government, and a large number of plates were prepared for the purpose ; but unfortunately circumstances prevented the completion of these works, and they must now be issued posthumously. Among other strange animals thus treated, may be mentioned the huge toothless flying reptiles (*Pteranodon*) of the Cretaceous period ; the land reptiles (*Dinosauria*) of the Jurassic and Cretaceous periods, of which Professor Marsh discovered most of the known types and proposed the first scientific classification ; the Cretaceous swimming reptiles, or *Mosasauria* ; the Jurassic and Cretaceous mammals ; the early ancestors of the horses ; and several remarkable early groups of mammals, among which were the huge quadrupeds which he termed *Brontotheria*. To the last he displayed his usual activity, and his final paper on some Dinosaurian footprints appeared only in the number of the *American Journal of Science* current at the time of his death.

The main feature of Professor Marsh's work, judged from a scientific standpoint, consists in its concise mode of expression and profuse allowance of excellent illustration. Some of his critics, indeed, have said that the value of his publications depends more upon the artist than upon the Professor's pen. They contain very little generalisation and are never tainted by preconceived ideas such as sometimes distort more philosophical minds. They thus afford a mine of accurately-recorded facts which will ever be of permanent value, even when the present phase of biological thought and speculation has passed away.

Professor Marsh was well known in Europe as a frequent visitor, and had many interests in addition to those centred in palaeontology. He was an enthusiast in Japanese art, in many other kinds of art, in the growth of orchids, and in the care of his Alderney cows. His bachelor home in New Haven, now bequeathed to Yale, was replete with art treasures and books ; and his garden extended over four ordinary "squares." He was a Foreign Member of the Geological Society of London, and received the first Bigsby Medal from that Society in 1877. In 1882 he was appointed Director of Palaeontology to the U.S. Geological Survey, and in 1883 he became Honorary Curator of Vertebrate Palaeontology in the National Museum, Washington. From 1883 to 1896 he was President of the National Academy. He was honorary Ph.D. of Heidelberg, and Correspondent of the Institute of France (Academy of Sciences), from which he received the Cuvier Prize two years ago. His great palaeontological collections were presented to Yale University by deed of gift on January 1, 1898. His will bequeaths the whole of his other property to the same university, of which he had been so long a conspicuous ornament.

AXEL THEODOR VON GOËS.

BORN JULY 3, 1835, RÖKS, ÖSTERGÖTLAND, SWEDEN;
DIED AUGUST 1897, STOCKHOLM.

OF so retiring a disposition was this excellent zoologist that even his death remained unnoticed for a year and a half by his colleagues in this country. It may not be too late for a few notes. The son of a nature-loving physician, Goës studied medicine at Upsala from 1854 to 1860, and in 1861 joined Torell's Spitzbergen expedition as naturalist and surgeon. On his return he joined Prof. Malmgren of Helsingfors in a research into the marine fauna around the Norwegian Finmark. In the summer of 1862, with a grant from the Swedish Academy of Sciences, he investigated the fauna off the west coast of Sweden. Having taken his licentiate examination at Upsala in 1864, he obtained the post of government and garrison physician to the former colony of Sweden on St. Barthelemy in the West Indies. Here he spent nearly five years, working on the fauna and flora of the Caribbean Sea, both from its greatest depths and from the shores of the island. His important collections are preserved in the State Natural History Museum at Stockholm. He returned to Sweden in 1870, bringing with him a wife, the daughter of the governor of the colony. Till 1895 he served as provincial physician in various districts, and then retired to pursue his natural history studies in Stockholm. As physician, Goës devoted much attention to the broader aspects of national hygiene, and was a strong advocate of the restriction of reproduction in those physically defective.

He was a devoted and able student of the Foraminifera, and his paper on this group from the Caribbean waters was a valuable contribution to the many attempts to bring into line the numerous variations to which authors had wrongly accorded specific rank.

Our information is mostly obtained from the Swedish medical magazine *Hälsovården*, to which, as well as to *Eira*, *Land och Folk*, and *Ymer*, he contributed many articles of more general interest.

The deaths are also announced of OTTO BÖCKELER, an investigator of the Cyperaceae, at Varel in Oldenburg, on March 5, in the 96th year of his age; at Rome, Count Abbé FRANCESCO CASTRACANE degli ANTELMINELLI (1817-1899), one of the leading authorities on diatoms; JOSEPH J. DOWLING, on February 2, at Foxrock, Dublin, a keen ornithologist and frequent contributor to the *Field*, and *Land and Water*, during the last twenty years; Sir DOUGLAS GALTON, K.C.B., F.R.S., D.C.L., LL.D. (1822-1899), general secretary of the British Association for 25 years, and president in 1895, a renowned authority and progressive worker in connection with sanitation; OTTO GELERT, systematic botanist in Copenhagen, on March 20; SYLVANUS HANLEY, the well-known conchologist; JOHN LEE, botanist, January 20, at the age of 49; Dr. OLIVER MARCY, professor of natural history in North-Western University, Evanston, U.S.A.; CHARLES NAUDIN, member of the Paris Academy of Sciences, and believed by some to have anticipated Darwin as regards the idea of natural selection, at the age of 83; Dr. P. L. RIJKE, of the University of Leyden, 86 years of age; on February 27, Dr. GUSTAV SCHOCH, docent in entomology in the Polytechnikum in Zürich; JOSEPH STEVENS, for some years honorary curator of the Reading Museum, and a student of archaeology and geology, on April 7, at the age of 81; J. H. WIBBE, botanist, on January 7, at Schenectady, N.Y., at the age of 60; FRANZ WOENIG, the botanist, at Leipzig; Surgeon-Major GEORGE CHARLES WALLICH, a pioneer in deep-sea exploration, on March 31, in his 84th year.

CORRESPONDENCE.

PROFESSOR MORGAN ON MR. HERBERT SPENCER.

I HAVE been considering Professor C. Lloyd Morgan's critique (*Nat. Sci.* December 1898) of Mr. Herbert Spencer's *Biology*. Therein the dynamic element in life, by which is meant an underlying "principle of activity," seems to occupy a considerable amount of attention. Is this principle inherent in organic matter? Mr. Spencer thinks it is; but how are we to realise the fact? That is to say, how are we to account for the "origin" of what is known as vitalised matter? how can the chasm which separates living from dead matter be bridged? Mr. Spencer admits, on the one hand, that the processes which go on in living things are incomprehensible as results of any physical actions known to us; and, on the other hand, he must assume that living matter originated during a long stage of progressive cooling, in which occurred the formation of molecules more and more heterogeneous. Mr. Spencer here makes an assumption which is quite gratuitous, but it stands to his credit that he proceeds no further in the business. He practically admits that the heterogeneous molecules have got nothing to do with the definite combination of heterogeneous changes, etc., which enter into his conception of life. He owns that in this direction our explanations finally bring us face to face with the inexplicable, and there the matter rests. But Professor Morgan is not quite satisfied. With true journalistic instinct he fears that Mr. Spencer is false to the evolution which he has so eagerly and lavishly professed, and therefore a reference to the peculiarly Teutonic poetico-mystical distinction between the noumenon and the phenomenon is deemed advisable and unhesitatingly called into requisition. If we only could positively cognize "things in themselves," the Professor seems to imagine, then we should be able to fully and clearly understand how it has come to pass that the "more and more heterogeneous molecules" of dead matter suddenly jumped as it were into life, and we should be able to rigidly measure and estimate the resultants of the properties of the component earthly matter, etc. Evolution itself comes within the same sweep. "We formulate the laws of evolution in terms of antecedence and sequence; we also refer these laws to an underlying cause, the noumenal mode of action of which is inexplicable." That is to say, the cause of evolution as a process in nature is referred to the noumenon "the thing in itself," which is merely a matter of supposition, a something which we do not scientifically know, but can only suppose by dint of a high-strung imagination.

Who would now be rash in asserting that the erstwhile favourite pet fad of our most talented poets, literates, and journalists had not suffered degradation when it is compelled to fall back, so to speak, on the abstruse casuistry of German metaphysics? There is a certain mental condition, as Wordsworth well knew, which is barely able to separate and distinguish between the mind within and the matter without, which is not sure whether, for instance, a post met with on the roadside is inside one's head or outside of it. Now, this is just the sort

of poetical idealism which calls in the "noumenon" as a basis for what is apparently only "phenomenon" seen. The true scientific metaphysics has no need of this poetic distinction. Matter is directly known in itself as possessed of qualities; there is nothing really behind it. The phenomena of the world, as reviewed by science, are not merely formulated in terms of antecedence and sequence; they are really considered as standing in the relation of cause and effect, which is an intuitive judgment underlying a portion of our empirical knowledge. There is no reference whatever to a supposititious underlying cause, nor do we know or understand anything whatsoever about the noumenal mode of action of any cause; all this is truly inexplicable. It is hoped, on behalf of the progress of science in this country, that Mr. Herbert Spencer's "inexplicable" may be interpreted in some such way as here suggested. All who recognise in the Darwinian labours an heroic but vain attempt to harmonise a rising and aggressive science with the best interests of poetry, literature, and journalism (all of which are excellent in their way), will no doubt enthusiastically join in this hope.

P. Q. KEEGAN.

PATTERDALE, WESTMORELAND.

BEES AND FLOWERS.

Will Mr. Bulman forgive me for saying that his paper in your February issue, pp. 128-130, is spoiled by its vagueness and even inaccuracy in regard to facts? No discussion about bees in general, as if they were all of one kind, can be of much value in this connection; nor do observations on the honey bee prove anything about wild bees. I have now for several years been observing the habits of bees in New Mexico, and can affirm that there are numerous species which ordinarily visit only one kind of flower; notably nearly all those of the large genus *Perdita*. Others confine themselves to one family, as Cucurbitaceae or Compositae. Others, again, visit many flowers of very diverse families. The detailed facts have been published, so I will not occupy your space by repeating them; they will be found in *Proc. Acad. Nat. Sci. Philadelphia*, Jan. 1896, pp. 25-107; *Botanical Gazette*, Aug. 1897, pp. 104-107; *Zoologist*, Feb. 1898, pp. 78-81, July 1898, pp. 311-314; and *Bull. Sci. Lab. Denison Univ.*, xi. (1898), pp. 41-73. These references merely relate to my own observations, and are cited in defence of the statements above made; but of course there is abundant testimony from other sources.

T. D. A. COCKERELL.

NEW MEXICO COLLEGE OF AGRICULTURE AND MECHANIC
ARTS AND AGRICULTURAL EXPERIMENT STATION,
MESILLA PARK, N.M., March 3, 1899.

PAGINATION.

SIR—Referring to your kind notice of our latest Museum Handbook on page 252 of the March Number, you will, I hope, forgive my expressing surprise that a journal so scrupulous in matters of bibliography as *Natural Science* should suggest a double pagination in a reprint. Such a complication gives a needless uncertainty to references, and it is difficult to see what good is gained by it. If it can be shown that the numbers 1, 2, 3 present any advantage over 97, 98, 99, then I will recommend my Committee to use a double pagination, but not before. The question was carefully considered, and it was not the additional cost which determined the action of the Committee.

OWENS COLLEGE, MANCHESTER,
March 17, 1899.

WM. E. HOYLE,
Keeper of the Museum.

NEWS.

THE following appointments have recently been made:—J. H. Burkhill, as assistant to the director of Kew; Prof. W. M. Davis, who holds the chair of physical geography in Harvard University, to be Sturgis Hooper professor of geology in the same university; J. H. Holland, as director of the botanical gardens in Calabar; Dr. Robert Muir, professor of pathology in University College, Dundee, to be professor of pathology in the University of Glasgow; C. C. H. Pearson, on the Kew staff, as assistant for India; A. J. Pieters, to succeed H. Hicks as first assistant botanist in the department of agriculture, Washington; Dr. Daniele Rosa, of the Zoological Museum in Turin, as professor extraordinarius of zoology in the University of Sassari; Mr. J. Arthur Thomson, M.A., lecturer on zoology in the School of Medicine, Edinburgh, to be regius professor of natural history in the University of Aberdeen, in succession to the late Prof. H. Alleyne Nicholson.

The Earl of Kimberley succeeds the late Lord Herschell as chancellor of the University of London.

The Smithsonian Institution have made the first award of the Hodgkins gold medal to Prof. James Dewar, F.R.S., in recognition of his researches on the liquefaction of air.

Prof. Milne Edwards, director of the Paris Natural History Museum, has received the Grand Cross of the Swedish Order of the Polar Star from King Oscar II.

The Paris Academy of Sciences has awarded half of the Lallemand prize to Mr. E. P. Allis for his memoir on the head of *Amia*, one of the Ganoid fishes.

A committee has been appointed for the purpose of presenting Dr. Richard Garnett, the late keeper of the printed books at the British Museum, with his portrait, as a mark of esteem and gratitude for his devotion to literature.

Dr. William Selby Church, senior physician to St. Bartholomew's Hospital, was elected president of the Royal College of Physicians of London, on March 27, in the room of Sir Samuel Wilks, Bart., retired. Dr. Church was Harveian orator in 1895.

The members of the Palaeontological Society have decided to express their appreciation of the services of their honorary secretary and editor, the Rev. Thomas Wiltshire, by presenting him with a testimonial. Subscriptions are not limited to members of the society, and will be received by the treasurer, Mr. R. Etheridge, F.R.S.

We learn from the *American Naturalist* that Prof. A. S. Packard, of Brown University, who has been wintering in the Mediterranean countries, is collecting materials for a life of Lamarck.

The *Times* of March 29 notes that another important advance has been made in the movement initiated by the Royal Geographical Society fifteen years ago, for the improvement of geographical education in this country, and the

recognition of the subject as a field of investigation of the first importance. One satisfactory result of this movement was the establishment, some twelve years ago, of Readerships in Geography at Oxford and Cambridge. These Readerships were substantially subsidised by the Royal Geographical Society. At the end of ten years the subject had obtained so firm a hold at Oxford through the activity of the Reader—Mr. H. J. Mackinder—that the University undertook to maintain the chair without further assistance from the society. Owing to certain local circumstances which it is unnecessary to specify, matters have not advanced quite so far at Cambridge, though the present Reader—Mr. Yule Oldham—is doing excellent work, which has been appreciated at the University.

At Oxford, as has been stated, a further step forward has been taken. Hitherto Mr. Mackinder has performed the ordinary functions of a Reader, which consist mainly in giving a certain number of lectures in each term; but it has been realised that the utility of the subject in various directions is so great that something more is now required. The result is, that there is little reason to doubt that before the end of the year a fully equipped School of Geography, or a Geographical Institute, will be established at Oxford, under the superintendence of the Reader, Mr. Mackinder. The Royal Geographical Society has offered £400 a year, for five years, towards the maintenance of this school, on condition that the University contribute an equal sum. The delegates of the Common University Fund have agreed to contribute £300 towards the University's share, and early in the Easter term the Curators of the University chest will be asked to add another £100, and there is every reason to believe that Congregation will approve the decree. The scheme will be under the supervision of a committee of eight,—four, with the addition of the vice-chancellor *ex officio*, to represent the University, and three the Royal Geographical Society. The Reader will act as director of the school, and will have an assistant, besides two lecturers who will deal with special aspects of the subject.

The late Prof. O. C. Marsh, who died at Newhaven, on March 18, is said to have left his entire estate to Yale University. It is thought that it will amount to \$150,000. He has left his house and grounds to form a botanical garden for the University. It will be remembered that in January 1898, Prof. Marsh presented his magnificent palaeontological, geological, and ethnological collections to the University of Yale.

An anonymous offer of £25,000 has been made to Birmingham University, on condition that a total amount of £225,000 is reached in a year.

The Chelsea Physic-garden has been saved from the builder. We learn from the *Times* that "The garden has been handed over to the trustees of the London Parochial Charities, who have agreed to dedicate a sum of £800 yearly to its maintenance. Under the new scheme the garden is to be administered exclusively for the promotion of the study of botany, with especial reference to the requirements of general education, scientific instruction, and research in botany, including vegetable physiology, and instruction in technical pharmacology, as far as the culture of medical plants is concerned. The practical management of the garden will be vested in a committee formed of representatives nominated by the trustees of the London Parochial Charities, the Treasury, the Lord President of the Council, the Technical Education Board, the Royal Society, the Royal College of Physicians, the Society of Apothecaries, the Pharmaceutical Society, the London County Council, and the Senate of the University of London. Earl Cadogan, and his successors, as representing Sir Hans Sloane, who conveyed the garden in 1722 to the Apothecaries' Company in trust for the encouragement of botany, is also a member of the committee. The garden, which comprises nearly four acres, facing the Embankment, was founded about 1673 by the Apothecaries' Company, and held by them on lease until 1722, when it was conveyed to them by Sir Hans Sloane on the trusts already

mentioned, with a proviso that, if the conditions were not fulfilled, the land should be held by his heirs in trust for the Royal Society or College of Physicians to carry on the garden for the same purpose. The Apothecaries' Company have recently found difficulty in keeping the garden in a proper state of efficiency, and neither the Royal Society nor the College of Physicians were prepared to undertake the trust on the condition of providing funds for its maintenance. The only course then appeared to be to sell the garden and apply the purchase money on a *cy-près* object, but, happily, the trustees of the London Parochial Charities have come to the rescue and saved the garden."

It has been decided to execute various special works at Kew Gardens in the course of the present year, including new filter bed, estimated to cost £2700; experimental well near the river, £200; new frame for Alpine plants, £120, etc. A sum of £200 will be set apart for purchases for the museum.

We have received a polyglot advertisement of the Ghizeh Zoological Gardens, near Cairo. The collection already includes a fair representation of mammals, birds, and reptiles, including "mongeese" (a plural which we have never had the courage to venture). Among other attractions are over 6 miles of paths (of which over 3½ miles are paved with coloured mosaic), the grottoes erected in the time of Ismail Pasha, and over twenty bridges.

In view of the visit of the British Association to Glasgow in 1901, an effort is being made to draw up complete lists of the Fauna, Flora, and Geological features of the Clyde District. A Natural History sub-committee has been formed and the zoological part of the work has been portioned out among many workers. The convener is Prof. John Young, M.D., the University, Glasgow; the vice-convener, Prof. Malcolm Laurie, D.Sc., St. Mungo's College, Glasgow; and the secretary, Rev. G. A. Frank Knight, M.A., Almanarre, Garelochhead. Information is specially desired as to (1) Distribution of Species; (2) Papers in Magazines, Journals, and Transactions of Societies, which might otherwise be overlooked; and (3) Names of workers in the different departments who might be willing to assist.

The area, as arranged by the Committee to be overtaken, is—"the natural drainage area of the Clyde, and of all the sea lochs which form extensions of its estuary." The northern limit, therefore, is the watershed beyond the head of Loch Fyne, and the southern boundary has been defined as a line drawn between the Mull of Cantire and the most southerly point of Ayrshire. It is a big undertaking, but the number of co-operating naturalists is already large, and we may confidently look for a valuable handbook in 1901.

An international veterinary congress will be held at Baden, August 9-14, 1899. The members of the congress will consist of delegates from foreign countries, as well as from the German empire. On the programme it is announced that an attempt will be made to prepare a uniform anatomical nomenclature, of which there is much need.

Prof. William Somerville, of the Durham College of Science, who is well known as a strenuous representative of the science of agriculture, has made numerous interesting agricultural experiments in the north of England, the results of which have been recently published in a County Council Report.

Prof. Cossar Ewart gave three lectures on zebras and zebra hybrids at the Royal Institution in April, and among others to follow we may note those on geology, by Prof. W. J. Sollas; on the atmosphere, by Prof. Dewar; on water weeds, by Prof. L. C. Miall; on the structure of the brain in relation to its functions, by Dr. Frederick Walker Mott; on pictures produced on photographic plates in the dark, by Dr. William James Russell; on climbs and explorations in the Andes, by Sir William Martin Conway; and on the discovery of the future, by Mr. H. G. Wells.

The ninth University Extension Meeting at Oxford will be held from July 29 to August 23, and it is said (we have received no formal programme) that some of the lectures have been arranged to illustrate the progress of science between 1837 and 1871. There will be lectures by Professors Gotch, Poulton, Sollas, Miers; and by Messrs. G. C. Bourne, A. W. Brown, Arthur Ransome, G. J. Burch, H. N. Dickson, and Reginald Farrar.

The Annual Report of the Zoological Society of London for 1898 shows receipts £29,208, an increase of £495 over that for 1897. This is largely made up by the subscriptions, as there is a falling off in "admissions" and other items. On the "payments" side there is an increase in salaries and pensions and in food for animals, and a new and gratifying item, "Grants in aid of science" £200. Sir William Flower still remains president, we are glad to see, and Dr. John Anderson, W. E. De Winton, Dr. Charles Gatty, Sir Hugh Low, and Dr. Henry Woodward are the new members of council. On the committee of publication F. E. Beddard, Sir George Hampson, Bt., and A. D. Michael replace Herbert Druce, E. T. Newton, and Oldfield Thomas, retired. The *Transactions*, vol. xiv. part 5, has been issued.

The prizes to be awarded in 1900 by the Belgian Royal Academy are announced. In natural science the subjects for essays are:—the geological formations at Comblain au Pont; the physical modifications produced in minerals by pressure; the structure and development of the Platoda; the presence of a nucleus in the Schizophytes; and the Devonian flora of Belgium. The essays may be written in French or Flemish, and must be sent to the secretary before August 1, 1900. The prizes are gold medals of 600 francs value.

The Hull Scientific and Field Naturalists' Club has issued an attractive programme of meetings and excursions for the summer session. Some of the excursions are in connection with the Yorkshire Naturalists' Union, to which this society is affiliated.

The thirtieth annual meeting of the Norfolk and Norwich Naturalists' Society was held at the Castle Museum on March 28, the president, Mr. J. H. Gurney, F.Z.S., in the chair. Mr. J. T. Hotblack was elected president for the coming session. The retiring president gave an address and read a paper on "The Bearded Titmouse and the Norfolk Broads." This is one of the twenty species for which the British list is indebted to the productive county of Norfolk. Here it was discovered by Sir Thos. Browne, who, through Ray, brought it to notice in 1674. Practically, the bearded titmouse is limited at the present day to the Norfolk Broads district, an area twenty-five miles by thirteen, of which part is marsh, where it still breeds annually.

At the meeting of the Geologists' Association, April 7, a paper on "The Geology of Brittany, with special reference to the Whitsuntide excursion," was communicated by Charles Barrois, D.Sc.

We have received the Report of the Committee of the Bristol Museum for the two years from October 1, 1896, to September 30, 1898. It is announced that the valuable geological collections of the late curator, Edward Wilson, have been presented to the Museum by his surviving brother and sister. Various structural improvements have been made. The top floor has been furnished with a plastered ceiling, thus rendering it useful for the storage of specimens. Two workrooms have been erected in the yard. The zoological specimens are being remounted and exhibited in smaller cases, just as is being done in so many other museums. The collection of British Lepidoptera has been re-arranged and re-labelled, with the help and generosity of G. C. Griffiths. The specimens of local rocks have also been re-arranged. Special temporary exhibits have been brought together in connection with public holidays: the first, a collection of books, manuscripts, and pictures, bearing upon the life of

Thomas Chatterton, the poet ; the second, a number of drawings representing different features of bygone Bristol. Other special exhibits of antiquities and geological specimens were arranged for the meeting of the British Association. The Report ends, as such reports are wont, with a complaint of overcrowding.

The tenth annual meeting and conference of the Museums Association will be held in Brighton in the first week of July. The Mayor of Brighton, Mr. A. J. Hawkes, is the president-elect, and Mr. B. Lomax of the Brighton Museum is local secretary.

£50,000 has been left to the Trustees of the British Museum for the extension and improvement of the Library and Reading Room, by the late Vincent Stuckey Lean of Clevedon. Bristol City Libraries benefit to the same amount, under the same will.

The large *Ichthyosaurus platyodon* lately received at the British Museum (Nat. Hist.) from Warwick, is now in place on the wall of the Gallery for Fossil Reptiles. Although the proposed re-arrangement of the Ichthyosaura is not yet complete, the new specimen can be well seen. It is more perfect than the older specimen of the same species, that being in part plaster. A feature of the general re-arrangement will be the introduction of outline sketches of the various genera showing the bones in natural positions, which one has seen at Brussels, and which is of great convenience to the student.

We learn from *The Scientific American* that Brooklyn is to have a children's museum located in the Bedford Park Museum. Prof. W. H. Goodyear, from whom the suggestion emanates, has suggested that the initial purchase should be the technological series prepared in Paris under the title *Musée Scolaire*. To this will be added collections illustrating natural history, and the museum will also serve as a model for schoolroom decoration.

At the meeting of the Royal Geographical Society on March 26, the president, Sir Clements Markham, said :—" In my opening address this session, in referring to the urgency of obtaining funds for an Antarctic expedition, I expressed my conviction that the spirit which influenced the patriotic adventurers of the Elizabethan age was still alive among us. Many good men and true have answered to my appeal ; but I now have the pleasure of announcing to you an act of unselfish liberality which does, indeed, remind us of the merchant princes of the days of old. Our associate, Mr. L. W. Longstaff, a Fellow of this society of many years' standing, has subscribed a sum which virtually puts an end to our chief difficulty. We shall be enabled at least to equip an efficient expedition consisting of one vessel, and to co-operate with the Germans in the scientific exploration of the Antarctic regions. You will like me to read to you the letter I have received from Mr. L. W. Longstaff, from which you will learn the noble motives that have actuated him, and the munificence of his contribution :—

" To the President of the Royal Geographical Society.

" Dear Sir Clements Markham—Being convinced of the imperative need of the immediate preparation of a British expedition, I have the pleasure to inform you that I have this day paid to the credit of the National Antarctic Expedition, with Messrs. Cocks, Biddulph, & Co., the sum of £25,000, which, I trust, will meet the exigency of the case.

" Though my attainments are but slight, I have all my life been much interested in scientific matters ; and, as a Fellow of our society for nearly thirty years, it gives me peculiar pleasure to be able thus to contribute towards the advancement of our knowledge of the planet on which we live.

" I am, dear Sir Clements, yours faithfully,

" LLEWELLYN W. LONGSTAFF.

" Ridgelands, Wimbledon, March 22, 1899."

I will now ask the meeting to pass a cordial vote of thanks to Mr. L. W. Longstaff, which I shall have great pleasure in conveying to him." The vote of thanks was seconded by Lord Lister, who said, *inter alia*:—"The British Antarctic Expedition is now assured, and the disgrace which would have been attached to this country for not rising to this great occasion is prevented. I need hardly say how deeply grateful we all feel to the donor of this great gift. It is a matter of peculiar satisfaction to myself that he is the son of a distinguished member of the medical profession. I do not know whether Lord Iveagh's magnificent gift to the General Institute for Preventive Medicine may have had anything to do with suggesting the idea to Mr. Longstaff. We can only hope that donations of this splendid kind will be plentiful in the future." Sir Clements Markham, interviewed by the *Central News*, said the fund for the Antarctic Expedition now amounted to £40,000. That would be sufficient to fit out one ship, if the strictest economy were exercised. It was under consideration, he said, to have the vessel built in Norway, as a wooden one could be got cheaper there than in England. It must be a wooden one, because the principal object of the expedition was to study magnetic influences in Antarctic regions, and an iron vessel would upset the calculations as to the magnetism. No one had as yet been selected to take command.

The first part of the *Fauna Hawaïensis*, or the Zoology of the Sandwich Isles, being results of the explorations instituted by the joint committee appointed by the Royal Society and the British Association, and carried on with the assistance of those bodies and of the trustees of the Bernice Pauahi Bishop Museum at Honolulu, is about to be issued by C. J. Clay and Sons, Cambridge University Press Warehouse.

This work is published by the committee and edited by their secretary, David Sharp, M.A., F.R.S., Curator in Zoology of the Museum of the University of Cambridge; when complete it will probably consist of two volumes, as it is intended to give an account, more or less full, of the whole of the land-fauna of the islands. This fauna is of very great interest, not only from its geographical isolation, but also on account of its being rapidly extirpated by the progress of cultivation, and the introduction of foreign species which prey upon, or consume the food of, the original natives—many of the latter being already extinct.

The first part, containing 122 pages Royal 4to, two plates and a map, includes the Hymenoptera Aculeata (bees, wasps, and ants), of which about 200 species, mostly undescribed, have been obtained, and is by R. C. L. Perkins, B.A., who has carried out the explorations under the direction of the committee and Prof. Auguste Forel.

Prof. Boyd Dawkins announces that the Kent Coal Exploration Company have struck the coal-measures at Ropersole Farm, Barham, midway between Canterbury and Dover. This is about 9 miles from the shaft at Dover. The coal was met with at about the same depth, and the boring will be continued so as to allow of a section being made which will give a comparison of the thickness of the seams with those of Dover.

Mr. J. Stanley Gardiner, recently elected Balfour student of the University of Cambridge, left Marseilles on April 5 for the Island of Minikoi, situated about half-way between the Maldivian and Laccadive Islands. He is accompanied by Mr. L. Borradaile, of Selwyn College, and Mr. C. F. Cooper, of Trinity College, will join the expedition during the summer.

After spending about three months at Minikoi, it is proposed to start for the Maldivian Islands about September, and employ the next six or seven months in surveying these islands. The expedition will enter at Male, the Sultan's capital, and subsequently sail all round the group.

The main object of Mr. Gardiner's expedition is to study the formation of the coral reefs and everything pertaining to them. Especial attention will be directed to the following points:—(1) The depth at which reef-building

organisms can live in sufficient luxuriance to build up the reef; (2) the food of the coral polypes, both in reference to Mr. Gardiner's discovery that certain of these give off oxygen, and in reference to the minute surface fauna; (3) the importance of currents both in hollowing out and filling in atolls, and also as affecting the distribution of life in the lagoons and on the reefs. The study of the inter-relationship of all the numerous organisms on a reef one to another will receive attention, and careful investigations will be carried on, by means of sounding apparatus and valved leads, as to the character of the sea bottom. Temperature observations at different depths, and samples of sea water, will also be taken.

The *Belgica*, with the members of the Belgian Antarctic Expedition under command of Lieutenant de Gerlache, which left Ostend in August 1897, arrived at Punta Arenas, Patagonia, on March 28, 1899. The vessel was for some time fast in the ice, but the expedition is said to have accomplished something. It visited Hughes Bay and Palmer's Land, and prepared a map of these regions; it obtained various geological specimens, and landed twenty times. It afterwards proceeded towards Alexanderland, and penetrated the ice-bound region to the westward. The extreme latitude reached was 71°36'; longitude, 92°.

Two members of the expedition died, viz. Lieutenants Danko and Wincke; the others are all well.

Dr. L. Buscalioni has set out for the Amazons to collect for the Botanical Museum at Rome.

The greater part of the funds required for the scientific exploration of the great African lakes, has now been provided, and Mr. J. E. S. Moore, the leader of the expedition which has been organised for the purpose, will leave immediately for British Central Africa. It is expected that the work will occupy two years, of which nine months will be given to the biological and physical exploration of Lake Tanganyika. The other lakes to be visited are Kion, Albert Edward, Nyanza, and the Albert Nyanza. It is hoped that the results of this mission will add largely to our knowledge of the zoology of the lakes in the Rift Valleys, and help to solve many problems in regard to the geology and past physical characteristics of this region of Africa.

The *Kronstadtski Viestnik* states that a Russo-Swedish scientific expedition will start this month for the Spitzbergen Archipelago. The Russians will be represented by Staff Captain Sergiebsky, the zoologist Vinitsky, Dr. Bunge, and the geologist and mining engineer, Chernyshev. They will go in the *Libau* icebreaker No. 2, and the *Bakan*, and join the Swedish party at Stockholm. The expedition intends to winter in Spitzbergen, the Russians at Edge Island, and the Swedes at Parry Island. The names of the Swedes and of their ships are not given.

It is announced (*Scientific American*) that the attractions of the Paris Exposition will include an artificial volcano at Grenelle. It will be 328 feet in height and 485 in diameter, but "the trip to the top will be made very agreeable," for the paths will pass by beautiful bowers and arbors. Vegetation is to be so arranged that visitors will pass from the splendid flora of the Mediterranean to the stunted shrubs found on craters. There will be eruptions at fixed hours, an imitation lava flow, and a reproduction of Dante's "Inferno." Surely.